**Union Calendar No. 194**

101st Congress, 1st Session - - - - - - - - - - - House Report 101-309

# OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION FISCAL YEAR 1990 PROGRAMS

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## REPORT

OF THE

## COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
## HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

OCTOBER 26, 1989.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

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## LETTER OF SUBMITTAL

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
*Washington, DC, October 26, 1989.*

Hon. THOMAS S. FOLEY,
*The Speaker, House of Representatives,*
*Washington, DC.*

DEAR MR. SPEAKER: By direction of the Committee on Science, Space, and Technology, I hereby submit to you the Committee's report entitled, "Oversight of the National Science Foundation, Fiscal Year 1990 Programs." The report was approved by the Committee on October 19, 1990. The study and preparation of the report was carried out by the Subcommittee on Science, Research and Technology.

Sincerely,

ROBERT A. ROE,
*Chairman.*

Enclosure.

## LETTER OF TRANSMITTAL

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
*Washington, DC, September 19, 1989.*

Hon. Robert A. Roe,
*Chairman, Committee on Science, Space, and Technology,*
*House of Representatives, Washington, DC.*

DEAR MR. CHAIRMAN: Enclosed is the report, "Oversight of the National Science Foundation, Fiscal Year 1990 Programs", which has been reviewed by the Subcommittee on Science, Research and Technology. The report reviews the fiscal year 1990 budget request and mandated three-year budget projection from NSF in light of the current multi-year authorization for the agency. The report also provides guidance to NSF on certain issues which have been explored in oversight hearings during the past year.

I request that the report be laid before the Committee for consideration at the earliest convenient time.

Sincerely,

DOUG WALGREN,
*Chairman, Subcommittee on Science, Research and Technology.*

Enclosure.

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101ST CONGRESS
*1st Session*

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REPORT
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# OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION FISCAL YEAR 1990 PROGRAMS

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Mr. ROE, from the Committee on Science, Space, and Technology, submitted the following

## REPORT

### I. INTRODUCTION

The National Science Foundation Authorization Act of 1988 (P.L. 100-570) authorizes appropriations for the National Science Foundation (NSF) for fiscal year 1989 through 1993. This is the first multi-year authorization which has been approved for NSF. The principal purpose of this report is to review the fiscal year 1990 budget request and mandated three-year budget projection from NSF in light of the authorization law.

In addition, the report will review certain issues which were explored in NSF oversight hearings before the Subcommittee on Science, Research and Technology held on March 9, 14 and 16, 1989, and in science education hearings before the full Committee on May 23, 24 and June 7, 1989.

### II. FISCAL YEAR 1990 BUDGET

*Comparison Between Request and Authorization*

The President's budget for NSF in fiscal year 1990 requested $2,149,000,000 in new obligation authority. This level of funding is $239,000,000 below the authorization of $2,388,000,000. The principal source of the difference in funding levels is the failure of the Administration to request funding for the Academic Research Facilities Modernization Program, which was created in the NSF Authorization Act of 1988 and funded at an authorization level of $125,000,000 for fiscal year 1990.

The remaining $114,000,000 difference between the request and the authorization is due to the request for Research and Related Activities being $108,000,000 below the authorization, the request for Science and Engineering Education being $15,000,000 below the authorization, and the request for the U.S. Antarctic Program being $9,000,000 above the authorization. The following table shows the comparison between authorization and request levels in the budget subcategories:

NATIONAL SCIENCE FOUNDATION BUDGET COMPARISONS

[In Millions of dollars] [1]

| Activities | Fiscal Year 1989 | | Fiscal Year 1990 | | |
|---|---|---|---|---|---|
| | Appropriations | Authorizations | Administration Request | Authorization Act | Difference Between Authorization & Request |
| Research and Related Activities: | | | | | |
| Biological, Behavioral and Social Sciences | 281.5 | 288.7 | 314.5 | 334.6 | 20.1 |
| Computer and Information Science and Engineering | 152.1 | 162.1 | 191.2 | 188.0 | −3.2 |
| Engineering | 187.3 | 198.0 | 211.2 | 229.5 | 18.3 |
| Geosciences | 310.3 | 320.9 | 341.3 | 372.0 | 30.7 |
| Mathematical and Physical Sciences | 503.2 | 507.8 | 553.5 | 588.5 | 35.0 |
| Science and Technology Centers | [2] .3 | 25.0 | [3] 20.0 | 30.0 | [4] 10.0 |
| Scientific, Technological and International Affairs | 58.3 | 56.0 | 67.3 | 65.0 | −2.3 |
| Program Development and Management | 91.6 | 95.0 | 104.0 | 103.1 | −0.9 |
| Subtotal, Research and Related Activities | 1,583 | 1,653.5 | 1,803 | 1,910.7 | 107.7 |
| Science and Engineering Education | 171 | 175.5 | 190 | 205.3 | 15.3 |
| U.S. Antarctic Program | 131 | 141.0 | 156 | 147.0 | −9.0 |
| Academic Research Facilities Modernization Program | 0 | 80.0 | 0 | 125.0 | 125 |
| Total | 1885 | 2,050 | 2,149 | 2,388 | 239 |

[1] Dollar amounts have been rounded.
[2] $25 M total; funds reprogrammed: MPS $13.70 M; BBS 4.15 M; GEO 0.90 M; and CISE 5.93 M.
[3] Additional funds for new starts. Total for S&T Centers in fiscal year 1990 is $45 M.
[4] This number is actually—15 since the Administration Request amount included only the new money in the program.

*Science and Engineering Education*

The Committee strongly endorses the proposed increases in undergraduate research and education programs at NSF. This growth of 63 percent, bringing the total funding of undergraduate programs to $105 million, is a welcome step which brings funding levels more in line with the recommendations of the National Science Board's Neal report on undergraduate education. However, the Committee is disappointed that the increase for precollege programs is only $10 million, or 8 percent, in a year in which the request for the overall NSF budget increases by 14 percent.

*Academic Research Facilities*

The Committee notes with displeasure that the budget request does not include funding for the Academic Research Facilities Modernization Program. Because of the unique mission of NSF within the Federal Government in sustaining academic research in science and engineering, the Foundation should take an advocacy position within the Administration for addressing the serious decline in the

university-based research infrastructure. The Committee is disappointed that NSF appears reluctant to assume this role.

*Science and Technology Centers*

As is seen from the preceding table, the request for Science and Technology (S&T) Centers is $20,000,000. However, the funding for the first set of S&T Centers, started in fiscal year 1989 at a level of $25,000,000, is not included in that figure. Consequently, the total proposed funding level for the S&T Centers program is at least $45,000,000 in fiscal year 1990, which exceeds the authorization level by $15,000,000 or by 50 percent. Should NSF receive appropriations permitting funding of the S&T Centers program at the requested level, the Committee notes that the provisions of Sec. 104(b) of the NSF Authorization Act of 1988 which relate to exceeding the authorization level in a particular subcategory by more than 10 percent would apply.

In the report (100–649) accompanying the NSF Authorization Bill, H.R. 4418, the Committee expressed concerns about initiating new centers programs:

> It is not the intention of the Committee to prohibit the initiation of the Science and Technology Centers program. However, the Committee believes that the scope of the initiative should be consistent with the need to sustain existing centers programs and national facilities and to maintain the vigor of the individual investigator grants program.

The Committee continues to believe that NSF should refrain from expanding new centers programs unless and until existing centers and national facilities are funded at levels required to allow them to be effective and to reach the goals for which they were instituted.

*Other Budget Initiatives*

The Committee applauds the proposed growth in the Computer and Information Science and Engineering Directorate budget that will sustain plans for establishing the national research and education network and will allow for hardware upgrades at the National Supercomputer Centers. Likewise, the Committee supports the environment/health/safety initiative proposed in the U.S. Antarctic Program to begin to correct past environmental abuses and to ensure improved environmental protection in the future; to improve medical facilities and provide safety experts for field parties; and to achieve year-round operations in the Antarctic with acceptable risk.

The Committee is pleased with the strong role NSF has played in the definition and planning of the U.S. Global Change Research initiative. The process which led to the FY 1990 budget presentation showing a cross cut of agency budgets supporting different parts of the research plan is a model which the Committee strongly encourages for future interagency research initiatives.

## III. THREE-YEAR BUDGET ESTIMATE

The NSF Authorization Act of 1988 amended the NSF Act of 1950 to require that NSF submit to Congress, each year, a three-year budget estimate at the time of the annual submission of the President's budget. The first submission under this new requirement is as follows:

NATIONAL SCIENCE FOUNDATION—FUNDING ESTIMATES FOR MAJOR ACTIVITIES

[In thousands of dollars]

| Activities | Fiscal year— | | (Percent increase) | Fiscal Year 1992 estimate | (Percent increase) |
|---|---|---|---|---|---|
| | 1990 estimate | 1991 estimate | | | |
| Research and Related Activities: | | | | | |
| Biological, Behavioral, and Social Sciences | 314,500 | 351,000 | (11.6) | 399,000 | (13.7) |
| Computer and Information Science and Engineering | 191,200 | 213,100 | (11.5) | 242,000 | (13.6) |
| Engineering | 211,200 | 236,000 | (11.7) | 268,000 | (13.6) |
| Geosciences | 341,300 | 381,000 | (11.6) | 433,000 | (13.6) |
| Mathematical and Physical Sciences | 553,500 | 618,000 | (11.7) | 702,000 | (13.6) |
| Science and Technology Centers | 20,000 | [1] 22,000 | ..... | [1] 25,000 | ..... |
| Scientific, Technological and International Affairs | 67,322 | 75,000 | (11.4) | 85,000 | (13.3) |
| Program Development and Management | 104,000 | 11,900 | (7.6) | 120,000 | (7.2) |
| Subtotal Research and Related Activities | 1,803,000 | 2,008,000 | (11.4) | 2,274,000 | (13.2) |
| Science and Engineering Education | 190,000 | 201,000 | (5.8) | 213,000 | (6.0) |
| U.S. Antarctic Program | 156,000 | 179,000 | (14.7) | 190,000 | (6.1) |
| Academic Research Facilities Modernization Program | 0 | 0 | ..... | 0 | ..... |
| Total NSF | 2,149,000 | 2,388,000 | (11.1) | 2,677,000 | (12.1) |

[1] Represents second and third year funding of new awards to be made in 1990.

For Research and Related Activities, the Committee notes that the increases projected for the principal scientific directorates are nearly identical percentages which reflect no prioritization across programs. In fact, the only sign of a programmatic decision is seen in the budget of the U.S. Antarctic Program and is due to the bulge created by the environment/health/safety initiative proposed in the FY 1990 budget submission.

The Committee further notes that the rate of increase projected for the Science and Engineering Education Directorate (SEE), which is about 6 percent, significantly trails the rate of increase for the overall NSF budget. Moreover, the rate of increase for SEE in these years in the NSF Authorization Act of 1988 is about 17 percent. The Committee deplores the failure of NSF to recommend resource allocations to SEE at levels consistent with the scale of the problems being addressed by the programs sponsored by SEE.

Finally, the Committee notes with displeasure the absence of projected funding for the Academic Research Facilities Modernization Program. The Committee expects NSF to be planning for the implementation of this program and to develop future budget requests to OMB which include funding for the program. Further discussion of the facilities program is in section VIII of this report.

## IV. RESOURCE ALLOCATION PROCESS

Despite efforts to double the NSF budget, which the Committee has strongly endorsed, appropriations available to NSF are likely

to fall short of levels needed to pursue all of the worthwhile research opportunities which arise and to address all of the weaknesses in the university-based research infrastructure. Consequently, NSF will continue to confront hard choices, often among competing projects and initiatives of equal scientific merit.

Perhaps the most difficult aspect of resource allocation is to determine equitable funding levels among different fields of science. Relevant criteria for making choices among competing research initiatives, such as the impact of the research on neighboring fields of science or the relevance of the anticipated results of the work to human welfare or to national goals, do not easily lead to quantitative measures that can be used to make decisions about specific projects. Likewise, there is no simple formula to determine the correct balance among interdisciplinary center awards, individual investigator awards, research facilities, and science education programs. Nevertheless, choices among projects are made and budgets are written.

Past NSF budgets show differences in rates of growth of the various research and education programs which reflect changing goals and responses to emerging research opportunities. It is important that the research communities which are affected by these choices understand how the process works and have opportunities to make their views known. When research communities which have not participated in recent budget growth complain, it is often due to a sense of exclusion from the allocation process.

*Committee View*

The Committee believes that it is important for NSF to provide an explanation of the process and criteria used in allocating resources for research and education programs. The Committee requests that NSF provide a report by January 31, 1990, describing how the various directorates develop and prioritize their proposed initiatives and describing how the cross-directorate, Foundation-wide budget priorities are established. The report should explain the role of the National Science Board in determining the priorities reflected in the final budget submission; describe how the views of different parts of the scientific community are incorporated in the planning process, as well as what efforts are made by NSF to solicit these views; explain how disciplinary reviews of research opportunities carried out by the National Academies or by scientific societies are used in the process and indicate how much influence they have; and describe the criteria used in determining the balance of resources allocated for research in different fields of science and engineering and, especially, indicate the weight given to the criterion of anticipated social benefits.

Also, the Committee would like to become more familiar with the planning process at NSF for support of national research facilities. NSF support for national facilities in the astronomical sciences has raised management issues which are discussed in a subsequent section of this report. The Committee requests that NSF prepare by December 15, 1990, a review of long-range plans for major upgrades and new construction as well as projections for operating budget levels for national facilities over the next three to five years. The Committee would like to know how NSF establishes

priorities for facilities construction and what management procedures are in place for tracking and estimating facilities costs.

In 1988, the Congress approved the first multi-year authorization for NSF. The purposes were to endorse the doubling of the NSF budget over five years and to provide some stability for long-term program planning. In conjunction with the multi-year authorization, NSF was required to submit to the Congress each year three-year budget estimates in order to provide Congress greater insight into the future program directions at NSF and to assist NSF in its own planning.

The initiation of multi-year authorizations was accompanied by the belief on the part of the Committee that a process was in place at NSF for establishing programmatic priorities. Unfortunately, the initial three-year budget submission for Research and Related Activities contains no evidence of a prioritization process. The rates of funding increase for the individual scientific directorates are essentially identical. If not provided with meaningful three-year budget trends, the Committee will be reluctant to endorse multi-year authorizations in the future.

The Committee understands that out-year budget estimates are subject to change. Unexpected research opportunities, for example, might require that adjustments be made. The reprogramming provisions included in NSF authorization acts are intended to provide this necessary flexibility. It is not unreasonable to expect NSF to provide planning information that will inform the Committee about broad priorities in future NSF programs.

In future three-year budget submissions, the Committee requests that NSF provide an explanation and rationale for the funding trends in the various budget categories and subcategories.

### V. SCIENCE AND ENGINEERING EDUCATION

No programs supported by NSF contribute more to the long-term benefit of the nation than the efforts to improve science and engineering education at the precollege and undergraduate levels in American schools, colleges and universities. This Committee has consistently urged that greater resources be allotted to addressing the serious deficiencies that exist in the delivery of science, mathematics and engineering education. The Committee is pleased that the FY 1990 NSF budget request proposes significant increases for undergraduate level programs that will bring total funding more in line with the recommendations of the 1986 National Science Board report, "Undergraduate Science, Mathematics and Engineering Education."

Unfortunately, regarding precollege science education programs, NSF has been reluctant to provide the level of resources that this Committee believes is only prudent in light of the scale of the problems to be overcome. The Committee notes the contrast between the $129 million FY 1990 budget request for precollege programs and the 1983 report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, which recommended a range of new and expanded NSF programs at funding level of nearly $500 million per year. The report recommended $349 million for teacher training institutes; $30 million for

development or regional on-site teacher training programs using new information technologies; $52 million for evaluation of existing curriculum, development of new curriculum, and provision of a clearinghouse for dissemination of information about curriculum; $36 million for research and development in educational applications of new technologies; and $10 million for research into the processes of teaching and learning.

*Committee View*

One consequence of the enormous growth of federal support for research in universities in the period following the Second World War has been the preeminence attached to research, at the expense of teaching, as the principal measure of faculty accomplishment. Young faculty members are well aware that proficiency in research leads to promotion and tenure and that teaching skill contributes little to their professional advancement. Since the quality of undergraduate instruction is a critical factor in cultivating student interest in science and engineering and in maintaining the human resource pipeline, the Committee requests that NSF explore possible actions which the Foundation could take that would result in greater attention by faculty to undergraduate instruction and that would reward outstanding teachers. The Committee requests that NSF provide a report on the results of this planning exercise by September 30, 1990.

The Committee strongly encourages NSF to plan for future growth in precollege science education programs consistent with the funding levels in the NSF Authorization Act of 1988.

The Committee encourages NSF to review the recommendation in the National Science Board report, "Education Americans for the 21st Century", to establish a national science and mathematics instructional resource facility. This facility should be involved in a range of activities, including research into the fundamental aspects of the integration of modern educational technology into the processes of learning and teaching, developing science and mathematics curricula that integrate computer systems and supporting materials effectively, and dissemination of information or model materials and practices.

## VI. SCIENCE AND ENGINEERING EDUCATION AT TWO-YEAR AND COMMUNITY COLLEGES

It is universally acknowledged that the workplace of the future will be increasingly complex, dependent on technology, and subject to rapid change. America's stature as a world economic power will depend directly upon the ability of its workers to cope with these conditions. The world of the future will demand of both blue and white collar workers a new level of technical competence. Our notions of basic education and job training must begin to reflect the necessity for new standards of mathematical and scientific ability. In addition, all citizens increasingly will confront public policy issues affecting their everyday lives that are driven by technology.

Since economic advancement is dependent on the abundant supply of competent workers, our economic prosperity and national security are at stake. Whether or not the U.S. continues to have

enough technically skilled workers to compete in the world marketplace will depend on the quality and availability of science and technical education. Specifically, we must design education programs that provide a strong foundation in science and mathematics, the ability to solve problems, and capability to adapt quickly to changes in the workplace.

The nation's 1,222 two-year and community colleges offer elements that can address these needs. They offer low-cost programs with flexible scheduling. The average yearly tuition at a two-year or community college is $660 and a two-year or community college is within easy commuting distance of 90 percent of all Americans. These facts take on added importance when it is considered that 55 percent of all first-time freshmen begin their studies at a two-year or community college and 41 percent of all undergraduate students in the U.S. attend these institutions. Also, 42 percent of black collegiate students, 54 percent of Hispanic students, 43 percent of Asian students and over 50 percents of women students attend two-year and community colleges.

Community colleges can design programs with local industry specifically geared to meet the immediate and future needs of local industry. They work directly with employers, labor unions, professional associations and community groups to develop and offer specialized training programs, as well as meet the critical skill needs of the armed forces. Two-year and community colleges play an increasingly significant role in local and state economic development strategies and have provided on-the-job training and worker retraining.

On October 31, 1988 the NSF sponsored a two-day workshop for the purpose of better understanding the conditions and problems of undergraduate science, mathematics and engineering education at two-year and community colleges. The workshop group consisted of educators and administrators from various undergraduate institutions from around the country, as well as representatives from business and industry. In a report published in June, 1989, the workshop group made a series of eight recommendations for improving undergraduate education.

In January 1989, NSF reported on a Committee request to review the status of science, technology, and engineering programs in two-year and community colleges. The report clearly points out specific problem areas and defines a role for NSF in helping to overcome some of these identified problems.

On April 11, 1989, the Subcommittee on Science, Research and Technology held a hearing on science and technical education at two-year and community colleges. Witnesses from several community colleges from around the country testified along with witnesses private industry, the Office of Technology Assessment, and the National Science Foundation. The Community College witnesses described the problems they face and the scientific and technical programs offered at their institutions. Also, they described the innovative programs to attract women and minorities and linkages to four-year institutions. The witness from the Office of Technology Assessment presented an analysis of general education trends and the NSF witness reviewed the current and planned activities aimed at two-year and community colleges.

*Committee View*

The Committee realizes the need for strong leadership in improving science, mathematics and engineering education at undergraduate institutions. The first two years of undergraduate study are particularly important for attracting students to careers in science and technology. The National Science Foundation is the appropriate federal agency to provide the required support and stimulus for nationwide activities aimed at reinvigorating instruction in these critical areas.

Specifically, the Committee points to the recommendations published in the recent NSF report entitled: "Report on the National Science Foundation Workshop on Science, Engineering, and Mathematics Education in Two-Year and Community Colleges." These recommendations involve program activities and partnership with other education institutions and private business. The Committee strongly urges the Foundation to act on these recommendations as well as expand on its current activities aimed at two-year and community colleges.

## VII. ASTRONOMICAL SCIENCES

Support for the astronomical sciences at NSF has been declining in constant dollars for several years. About two-thirds of the available funding is used for operations and new construction of facilities at three national centers, while the remainder supports the competitive research grants program. According to the Committee has received, the budget squeeze on the astronomy programs will not allow for continued operation of the existing facilities at the national centers. The Committee notes that a new facility, the Very Long Baseline Array, is under construction with a completion date of 1993 and with a total construction cost of $81 million.

*Committee View*

The principal issue which the Committee wishes to raise is not the total NSF funding level for the astronomical sciences. The Committee realizes that different fields of science can and do present convincing cases for increased funding support and that NSF must evaluate all program funding levels and make choices among them. The resource allocation process was discussed in a preceding section of this report.

However, the testimony which the Committee has received from the astronomy community does raise an important management issue. Given the constraints imposed by some minimum level of operating expenses for existing facilities, which we are told has been reached, and by commitments for construction of a new facility, a proposed overall budget level which is declining in constant dollars must imply either a reduction in support of research grants or the need to close some facilities. But the proposed FY 1990 astronomical sciences budget, which is increased by approximately the rate of inflation relative to the FY 1989 budget, shows an increase above inflation for astronomy project support and no proposed closures of facilities.

The Committee requests that NSF provide by January 31, 1990, a report providing a perspective on NSF plans for support of astrono-

my facilities. The report should indicate which facilities are likely to be deactivated over the next three to five years and provide an estimate of operating funds required for astronomical facilities over the next three years.

NSF has rightly stressed the importance of international collaborations in the construction of ground-based astronomy facilities. The Committee requests that NSF include in the aforementioned report the current status of plans for such international collaboration for construction of optical telescopes or for any other purposes involving astronomical facilities.

### VIII. BEHAVIORAL AND SOCIAL SCIENCES

Research in the behavioral and social sciences can make important contributions to addressing national problems, such as increasing worker productivity, improving educational methodologies, preserving the environment, and reducing crime and drug abuse. A vigorous program of basic social and behavioral research in psychology, political science, economics, linguistics, sociology, and related disciplines is in the national interest and should receive a firm commitment from NSF.

The Committee has strongly supported restoration of funding to the behavioral and social sciences following the severe cuts in the early 1980's. The Committee notes, however, that, while reaching the funding level of 1980 in current dollars, the behavioral and social sciences research budget has declined by 30 percent in constant dollars. The 1988 National Research Council report "The Behavioral and Social Sciences: Achievements and Opportunities", identifies areas of opportunity that require expanded support, mainly in basic research, and estimates that an addition of about $60 million should be added to the NSF budget. The question arises as to whether the resources now allotted by NSF, and the projected rate of increase, are consistent with the important contributions the behavioral and social sciences can make to our society.

*Committee View*

In testimony received during NSF oversight hearings, frustration was expressed by representatives of the behavioral and social sciences community about the lack of attention paid by NSF to the recommendations of the recent National Academy of Sciences report on the behavioral and social sciences. Clearly, an evaluation of the research opportunities in a field of science is a key factor in determining the appropriate level of resources that should be allotted. The Committee encourages NSF to review the findings and recommendations of the Academy report and compare them with the current research directions and resource levels in the NSF research programs in the behavioral and social sciences.

Principal support for the behavioral and social sciences at NSF resides in the Directorate of Biological, Behavioral and Social Sciences (BBS). However, research and education activities supported by other directorates, such as Science and Engineering Education or Geosciences (Polar Programs), may also involve disciplines primarily supported by BBS. The Committee requests that NSF review current administrative arrangements for the management

of research and educational activities in the behavioral and social sciences throughout NSF to ensure that the most effective and responsive mechanisms are in place. The Committee also requests that NSF prepare a summary of research and education activities in the behavioral and social sciences supported by NSF directorates other than the BBS directorate during FY 1989 and planned for FY 1990.

A further criticism of the behavioral and social sciences community has been that they have had few representatives on the National Science Board. The Committee requests that NSF document the composition of the Board by discipline area of its membership over the past twenty years and describe the rationale used to choose among qualified representatives from different fields of science and engineering in arriving at recommendations to the President for filling vacancies on the Board.

The Committee requests that a report on the behavioral and social sciences providing the information indicated in the preceding paragraphs be provided by January 31, 1990.

### IX. ACADEMIC RESEARCH FACILITIES

Throughout our Nation's history, the health of our economy and the strength of our national defense has been coupled with that of colleges and universities. This country looks to its college and universities for both new knowledge, as well as training for scientists and engineers. This linkage is truly unique. It is no coincidence that the United States, with its foundation of academic research and training, has led the world in all measures of achievement in science and technology.

Just at a time when more is expected of the academic community we witness crumbling buildings, obsolete equipment, and faculty shortages in important fields of science. Several recent studies and reports have been issued describing the dimensions of this crisis. The most prominent of these reports, "A Renewed Partnership" (Report of the White House Science Council, 1986), estimates the national facilities need at least $10 billion over ten years. The Council recommended the establishment of a facilities fund within NSF and an adjustment of the indirect cost allowance to address this problem. Further elucidating this problem, an NSF survey released in September, 1986, reveals that more than 80 percent of research administrators at doctorate-granting universities reported that the outmoded state and age of research facilities limited the scope of research. Also, research administrators indicated that funds have been directed away from research projects in order to maintain and repair facilities.

Lack of adequate facilities not only reduces the effectiveness of current research efforts, but also discourages many recent graduates from pursuing careers in university teaching and research. Instead, graduates in science and engineering will choose to enter the private sector where modern facilities and equipment are available.

In response to this disturbing problem, the Congress incorporated the Academic Research Facilities Modernization Program in the NSF Authorization Act of 1988. As prescribed by the law, NSF has devised criteria for administering the facilities program and would

be able to initiate it during fiscal year 1990. However, the NSF budget request for 1990 did not provide funding for the facilities program.

*Committee View*

The Committee strongly encourages NSF to develop a fiscal year 1991 budget request containing funding for the Academic Research Facilities Modernization program. The authorization levels for the facilities program in the NSF Authorization Act of 1988 added funding for the facilities program in addition to the schedule of increases needed to double the NSF budget for research and education activities over a five-year period. The Committee intends for NSF to advocate funding for the facilities program as an addition to projected increases in current Foundation activities.

## X. SUMMARY OF COMMITTEE VIEWS

The Committee generally endorses the FY 1990 NSF budget request for Research and Related Activities and for the U.S. Antarctic Program. However, the Committee is concerned about the proposed rate of increase for the Science and Technology Centers program and strongly disagrees with the proposed rate of increase for precollege science education programs.

The Committee finds the initial submission of the mandated three-year budget projection unsatisfactory. Future submissions will be expected to reflect the outcome of a prioritization process and to provide the rationale for projected changes in budget levels for the major activities.

The Committee strongly encourages NSF to provide in the FY 1991 and future budgets funding for the Academic Research Facilities Modernization Program. Further, the Committee reminds NSF of the budget targets for the Science and Engineering Education Directorate contained in the NSF Authorization Act of 1988. The Committee views these funding levels as essential for meeting critical national needs in precollege and undergraduate science, mathematics, and engineering education.

The Committee requests information regarding the process for determining the priority afforded research from different fields of science and engineering, as well as projections for national research facility construction and operation costs. A special report is requested on plans for support of national astronomical research facilities.

The Committee endorses the recommendations in the June 1989 NSF report on two-year and community colleges and encourages NSF to review the recommendation in the 1983 National Science Board report on the creation of a national science and mathematics instructional resource facility. In addition, the Committee encourages NSF to explore ways to stimulate greater attention by university faculty to undergraduate instruction in science and engineering.

The Committee requests that NSF review the program focus and administrative arrangements for research and education activities in the behavioral and social sciences. In particular, the Committee would like to know how current NSF research activities correspond

to the recommendations of the recent National Academy of Sciences report on research opportunities in the behavioral and social sciences.

## XI. SUMMARY OF REPORTS REQUESTED

In the preceding sections, the following reports were requested of NSF:

| *Location of Request* and *Subject:* | *Date Due* |
|---|---|
| Section IV.—Budget Prioritization Process | 1-31-1990 |
| Section IV.—Research Facilities Plan | 12-15-1990 |
| Section V.—Undergraduate Instruction | 9-30-1990 |
| Section VII.—Support of Astronomy Facilities | 1-31-1990 |
| Section VIII.—Behavioral and Social Sciences | 1-31-1990 |

## APPENDIX 1

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
*Washington, DC, January 26, 1989.*

Hon. ROBERT A. ROE,
*Chairman, Committee on Science, Space, and Technology,*
*House of Representatives, Washington, DC.*

DEAR MR. CHAIRMAN:

Enclosed is the National Science Foundation Budget Summary for FY 1990. NSF's budget request for FY 1990 is $2.15 billion, an increase of 14 percent above the FY 1989 appropriation. This request reaffirms the Administration's commitment to significant long-term growth in support for science and engineering research and education through a doubling of the Foundation's budget.

The FY 1990 request emphasizes three strategic themes:

Strengthening the disciplinary research base and improvement of academic science and engineering facilities (up 11 percent to $1.32 billion).

Expansion of group and center research activities to promote partnerships between individual investigators, industry, and universities in response to increasingly complex basic research problems (up 18 percent to $376 million).

Development of human resources through broadened participation, and improved science and engineering education at all levels (up 22 percent to 347 million).

The Budget Summary includes information on programs in all three areas as well as explains NSF's new initiatives for FY 1990. These initiatives include an Antarctic environmental safety and health program, increased support for research in global change, biodiversity, materials research, high performance computing, and mathematics.

I hope we have a chance to discuss these proposals in the near future. I look forward to working with you and the committee during the coming year to make this budget a reality.

Sincerely,

ERICH BLOCH,
*Director.*

Enclosures.

# National Science Foundation

## Washington, D. C. 20550

## FY 1990

## Budget Summary

New Obligational Authority:

| | |
|---|---|
| FY 1990 Budget Request | $2,149,022 |
| FY 1989 Appropriations (P.L.100-404) | 1,885,000 |
| Increase in New Obligational Authority | $264,022 |

Program Level:

| | |
|---|---|
| FY 1990 Budget Request | $2,149,022 |

FY 1989

| | |
|---|---|
| Appropriations (P.L.100-404 ) | $1,885,000 |
| Plus 1988 Carryover | 813 |
| FY 1989 Program Level | $1,885,813 |
| Increase in Program Level FY 1990/89 | $ 263,209 |

## SUMMARY OF FY 1990 BUDGET BY APPROPRIATION AND ACTIVITY (Dollars in Thousands)

| | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| RESEARCH AND RELATED ACTIVITIES | | | | | |
| Biological, Behavioral and Social Sciences | $265,080 | $285,581 | $281,530 | $314,500 | $32,970 |
| Computer and Information Science and Engineering | 123,913 | 148,726 | 152,080 | 191,200 | 39,120 |
| Engineering | 172,075 | 194,327 | 187,261 | 211,200 | 23,939 |
| Geosciences | 290,655 | 320,025 | 310,282 | 341,300 | 31,018 |
| Mathematical and Physical Sciences | 472,031 | 499,805 | 503,253 | 553,500 | 50,247 |
| Program Development and Management | 84,466 | 95,550 | 91,650 * | 104,000 | 12,350 |
| Science and Technology Centers | 0 | 30,000 | 326 | 20,000 | 19,674 |
| Scientific, Technological and International Affairs | 50,052 | 58,986 | 58,334 | 67,322 | 8,988 |
| Subtotal | 1,458,272 | 1,633,000 | 1,584,716 | 1,803,022 | 218,306 |
| Unobligated Balance Available Start of Year | (1,265) | -0- | (616) | -0- | 616 |
| Unobligated Balance Available End of Year | 616 | -0- | -0- | -0- | -0- |
| Adjustments to Prior Year Accounts | (4,766) | -0- | -0- | -0- | -0- |
| Unobligated Balance Lapsing | 143 | -0- | -0- | -0- | 0 |
| Proposed Supplemental to Increase PD&M Limitation | 0 | -0- | (1,100)* | -0- | 1,100 |
| Research and Related Activities Appropriation | 1,453,000 | 1,633,000 | 1,583,000 | 1,803,022 | 220,022 |
| SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION | | | | | |
| Teacher Preparation and Enhancement | 45,531 | 53,500 | 63,525 | 68,500 | 4,975 |
| Materials Development, Research and Informal Science Education | 37,811 | 43,500 | 44,002 | 49,000 | 4,998 |
| Undergraduate Science, Engineering and Mathematics Education | 19,026 | 23,500 | 28,001 | 30,000 | 1,999 |
| Research Career Development | 34,021 | 31,000 | 31,016 | 38,000 | 6,984 |
| Studies and Program Assessment | 3,240 | 4,500 | 4,500 | 4,500 | 0 |
| Subtotal | 139,629 | 156,000 | 171,044 | 190,000 | 18,956 |
| Unobligated Balance Available Start of Year | (61) | -0- | (44) | -0- | 44 |
| Unobligated Balance Available End of Year | 44 | -0- | -0- | -0- | -0- |
| Adjustments to Prior Year Accounts | (437) | -0- | -0- | -0- | -0- |
| Unobligated Balance Lapsing | 25 | -0- | -0- | -0- | -0- |
| Science and Engineering Education Activities Appropriation | 139,200 | 156,000 | 171,000 | 190,000 | 19,000 |
| U.S. ANTARCTIC RESEARCH PROGRAM | | | | | |
| U.S. Antarctic Research Program | 13,522 | 15,500 | 15,500 | 17,500 | 2,000 |
| Antarctic Operations Program | 85,243 | 92,200 | 87,353 | 102,200 | 14,847 |
| Major Construction and Procurement | 25,900 | 33,300 | 28,300 | 36,300 | 8,000 |
| Subtotal | 124,665 | 141,000 | 131,153 | 156,000 | 24,847 |
| Unobligated Balance Available Start of Year | (2) | -0- | (153) | -0- | 153 |
| Unobligated Balance Available End of Year | 152 | -0- | -0- | -0- | -0- |
| Adjustments to Prior Year Accounts | (16) | -0- | -0- | -0- | -0- |
| U.S. Antarctic Program Appropriation | 124,800 | 141,000 | 131,000 | 156,000 | 25,000 |
| TOTAL, NSF APPROPRIATION | $1,717,000 | $1,930,000 | $1,885,000 | $2,149,022 | $264,022 |

*Upon approval of the requested increase in the FY 1989 PD&M limitation, $1,100,000 will be transferred to the PD&M activity for cost increases resulting from the 1989 government-wide pay adjustment. Proportional reductions will be made in all other Research and Related Activities to accomodate this transfer.

## NATIONAL SCIENCE FOUNDATION
## FY 1990 BUDGET REQUEST

### OVERVIEW

The National Science Foundation (NSF) Budget Request for FY 1990 is $2.149 billion. The amount requested is an increase of $264 million or 14% more than the FY 1989 appropriations. The request includes the following appropriations:

(Millions of Dollars)

| Account | FY 1988 Request | FY 1989 Appropriation | FY 1990 Request | FY 1990 Request/ FY 1989 Approp. |
|---|---|---|---|---|
| Research and Related Activities | $1,633.0 | $1,583.0 | $1,803.0 | 13.9% |
| U. S. Antarctic Program | 141.0 | 131.0 | 156.0 | 18.9 |
| Science and Engineering Education | 156.0 | 171.0 | 190.0 | 11.1 |
| Total, NSF | $1,930.0 | $1,885.0 | $2,149.0 | 14.0% |

The FY 1990 Request proposes real growth in Research and Related Activities, including enhanced support for research facilities. It provides for continued increases in Science and Engineering Education programs, which have nearly doubled since FY 1987. It provides enhanced support of the U.S. Antarctic Program (USAP) through a special safety, health, and environmental initiative. This initiative marks an important commitment to improving safety and health conditions for United States personnel in the region and for safeguarding a unique natural environment. The program provides a model for other nations to emulate.

The FY 1990 Request reaffirms the Administration's plan to double the Foundation's budget and its commitment to significant long-term growth in support for research and education in science and engineering. It provides the funding necessary to significantly bolster support for the nation's research infrastructure, thereby enhancing our ability to respond to the many challenges facing this nation's science and engineering efforts.

How well the nation responds to these challenges and to the many scientific and technological opportunities available will have great impact on our national and economic security. Basic research and education have a direct and long-term effect on the national well-being, and our social and economic progress are increasingly dependent on technological innovation which promotes the maintenance of competitive positions in world markets.

NSF plays a pivotal role in promoting innovation through its support of the research infrastructure across a wide range of science and engineering disciplines and educational efforts. The knowledge base and skilled people produced by this infrastructure determine the pace of technological progress. The FY 1990 Request reflects a strategic framework for a significant and balanced investment in education, the generation of new knowledge,

and the transfer of new knowledge from producers to users. It emphasizes support of science and engineering research and education at U.S. universities and colleges, which are the primary source of our technical workforce and the major performers of basic research.

## NSF STRATEGY

The Foundation's FY 1990 budget request is organized around three strategic themes:

- **Strengthening the disciplinary research base and improving academic science and engineering facilities ($1.32 billion).**

  The predominant role of NSF is the support of disciplinary research in the major fields of science and engineering. This support is carried out primarily through grants to individual investigators; the support of graduate and undergraduate students; and the support of laboratory instrumentation and access to large specialized facilities, computers, and computer networks.

- **Expanding group and centers research activities ($376 million).**

  Group and center research programs promote new partnerships which are necessary to respond to the increasing size and complexity of many of today's research problems. Such programs support a setting for multidisciplinary collaboration among individual investigators, cooperation among universities and industry, and sharing of research tools. The growing importance of these activities is reflected in the establishment of a variety of research centers across the Foundation's programs during the past five years and through the support of a number of group research efforts which benefit from a coordinated approach.

- **Developing human resources, broadening participation, and improving science and engineering education at all levels ($347 million).**

  The Foundation addresses the human resources issue across all parts of the educational pipeline. It also seeks to broaden the participation of underrepresented groups, institutions, and geographic regions. Educational activities include support for students at all levels, teacher enhancement, and curriculum development. Programs across the Foundation focus on providing undergraduate research opportunities for faculty and students. Special programs address graduate and postdoctoral education and research. Efforts to broaden participation include research initiation programs directed toward minorities and women and programs that improve institutional and regional science and engineering infrastructure and capacity.

(Millions of Dollars)

| | FY 1989 Plan | FY 1990 Request | Change Amount | Change Percent |
|---|---|---|---|---|
| Disciplinary Research and Facilities | $1,191 | $1,322 | $131 | 11.0% |
| Centers and Groups | 319 | 376 | 57 | 17.9 |
| Education and Human Resources | 285 | 347 | 62 | 21.8 |
| PD&M | 90 | 104 | 14 | 15.6 |
| Total, NSF | $1,885 | $2,149 | $264 | 14.0% |

## DISCIPLINARY RESEARCH AND FACILITIES

Disciplinary research and facilities are the primary focus of NSF support, accounting for over 60% of the FY 1990 budget request. An increase of $131 million is sought over FY 1989 levels.

NSF support is broadly based across scientific and engineering disciplines, involving over 20,000 individuals at more than 1,500 institutions. It is this broadly based support for excellence, provided through a competitive merit review process, that helps assure the United States' strength in science and engineering.

Continued growth is requested for high priority areas such as genetics, mathematics, superconductivity, arctic research, ozone depletion research, microscale chemical processing, and fundamentals of software engineering and systems. Many of these areas reflect the growing complexity and multi-disciplinary nature of today's research problems.

Among the new and continuing areas of NSF research emphasis for FY 1990 which illustrate the challenges and opportunities facing the nation's scientific efforts are the following:

- **Global Change.** Expanded efforts in Geosciences and other disciplines seek to understand how the earth functions as a system of interrelated processes. These activities are important to our understanding of the causes and effects of global changes in climate and other environmental processes. These activities are NSF's contribution to the U.S. Global Change Research Program. The full federal global change research effort is described in a document accompanying the FY 1990 Budget entitled, "Our Changing Planet: A U.S. Strategy for Global Change Research".

- **Biodiversity.** A special initiative designed to address the widespread scientific concern over the loss of biotic diversity at all levels. Genetic diversity is essential because loss of species and habitats, for example, deforestation, have serious impact on economic development.

- **Materials.** A rapidly expanding scientific knowledge base is providing significant opportunities to advance the state of the art in materials processing. Research in this area will have great impact on the development of applications involving superconducting materials, semiconductors, submicron circuitry, and microelectronic technologies.

- **High Performance Computing.** Efforts in high performance computing and communication will advance research in computer and information science and engineering and serve the broader needs of investigators across all disciplines.

Disciplinary increases provided by this request will also enable the Foundation to address the need to increase the number, size, and duration of NSF grants and to boost funding for small scale research equipment.

The Foundation's support for national facilities provides access to large scale, advanced instruments and computing capability for the research community. Advanced instrumentation and computational power enhances individual research efforts and provides investigators with the tools required to accelerate the pace of scientific discovery.

Continued support and planned upgrades are critical for national facilities in astronomy, physics, and the geosciences. A major investment to upgrade advanced scientific computing facilities and networks is also planned.

A major new facility, **the High Magnetic Field Laboratory**, is proposed. This facility will provide unique opportunities for discoveries in materials, physical and biological sciences.

Initial funding for a major multi-year initiative to improve safety, health and environmental conditions in the U.S. Antarctic Program is requested. Our current facilities are inadequate to provide the safe and healthful conditions needed for the U.S. presence in the region. At the same time, protection of the unique and fragile Antarctic environment is of great concern.

CENTERS AND GROUPS

The FY 1990 request includes $376 million for centers and group activities, an increase of more than $56 million above FY 1989 plans.

NSF recognizes the need for large scale, long term efforts focused on complex problems. Centers and group research play a significant role in promoting the collaboration among individual investigators and across disciplines and sectors -- federal, state, and private -- that such problems require. Centers and group research also provide unique educational opportunities at the undergraduate, graduate, and postdoctoral levels.

The centers component will include funding for the following purposes:

- **Science and Technology Centers** will continue support for the FY 1989 group of 11 STCs, and will initiate a second competition for 8-10 STCs in FY 1990.

- **Engineering Research Centers** will continue with 2-4 new awards, for a total of about 19 NSF-supported centers addressing a range of critical problems.

- **Comprehensive Regional Centers for Minorities** will be expanded with 2-4 new awards.

- **Industry/University Cooperative Research Centers** will provide seed money for 8-12 new centers in emerging areas of technological opportunity.

Other center activities funded by the disciplinary programs include: Materials Research Laboratories, the Earthquake Engineering Center, a Center for Geographic Information and Analysis, the Plant Science Centers, and the Minority Research Centers for Excellence.

Group research is carried out by teams of investigators, each of whom brings different but complementary skills and experience to the study of complex problems. Coordinated research, shared data, and common instrumentation and equipment are dominant themes of this research mode.

Examples of group research activities include:

- Mathematical Sciences Groups emphasizing research combining advanced mathematics with other fields of science and engineering;

- Materials Research Groups focusing on complex problems in materials science and engineering, condensed matter, and materials chemistry;

- Engineering projects addressing broad systems-oriented problems in manufacturing and lightwave technology; and

- Long Term Ecological Research sites that will provide on-line research networks to support studies across many research areas, including biodiversity and global change.

EDUCATION AND HUMAN RESOURCES

The FY 1990 Request includes over $347 million for support of education and human resource development. This is an increase of $62 million over FY 1989 levels.

Trained and educated people are an indispensable resource for the nation's science and technology efforts. The quality and size of this resource pool will ultimately determine the future contributions of U.S. science and technology to national needs. NSF support for education and human resources enhances the quality of science, engineering, and mathematics education at all levels and in all types of institutions. Other efforts focus on

increasing the participation of groups and performers now underrepresented in the science and engineering human resources pool.

New and continuing pre-college activities will emphasize teacher preparation and enhancement, instructional materials development, informal science education, and the Young Scholars program. Special attention will be given to much needed mathematics curriculum reform at the middle school level. The Presidential Awards for Excellence in Science and Mathematics Teaching will expand to include elementary level teachers, in addition to middle and secondary level teachers.

The NSF-wide undergraduate program totals $104.9 million, an increase of $40.5 million (62.9 percent) over the FY 1989 target of $64.4 million. These activities are carried out in programs across the Foundation.

- Activities in course improvement and curriculum development will expand significantly to include more disciplines, e.g. chemistry, biology, and computer sciences.

- **Research Experiences for Undergraduates** supports students in special group projects and provides research opportunities under existing faculty research grants.

- **Research in Undergraduate Institutions (RUI)** and **Research Opportunity Awards** will continue to provide research opportunities for faculty from predominantly undergraduate institutions.

The **Graduate Fellowship** program will support over 2300 Fellows with an increase in stipend amounts. A new **Women in Engineering** component of the program will address the problem of the very low percentage of engineering faculty members who are women.

Support of programs for underrepresented groups will be expanded to $58.7 million, or a 19.2 percent increase over the FY 1989 target of $49.2 million.

Both the **Research Careers for Minority Scholars** and **Career Access for Women, Minorities and the Disabled** program will be increased substantially. Examples of other such programs include:

- CISE Minority Institutional Infrastructure
- Research in Minority Institutions
- Minority Research Initiation
- Visiting Professorships for Women
- Research Opportunities for Women

The Experimental Program to Stimulate Competitive Research (EPSCoR) will be expanded. **EPSCoR** supports research and educational programs in 16 States and Puerto Rico, broadening the geographic distribution of research quality.

In summary, the FY 1990 Budget Request presents a broad and balanced approach which emphasizes continued strengthening of the foundation of the nations's science and engineering efforts (people, instrumentation and necessary facilities); promoting activities and partnerships necessary to meet new technological challenges; and nurturing the traditional role of NSF as supporter of basic disciplinary research.

## ACTIVITY SUMMARIES

## RESEARCH AND RELATED ACTIVITIES

### Biological, Behavioral and Social Sciences

The FY 1990 Request for Biological, Behavioral, and Social Sciences (BBS) is $314.50 million, an increase of $32.97 million, or 11.7 percent, over the FY 1989 Current Plan of $281.53 million.

A major disciplinary research initiative in Biodiversity ($11.0 million) will address scientific issues surrounding the loss of biotic diversity at all levels, from genes to species to ecological communities. Support for individual and group projects will be increased in critical areas of systematic biology, ecology, and related fields.

BBS proposes a broad-based initiative focused on the design and development of shareable Biological Databases ($6.5 million). Sustained progress in understanding biological processes and the ability to capitalize on rapid developments in biological sciences are dependent on the capability to collect, manage, and manipulate large-scale databases.

Support for centers and groups is important to the progress of life sciences because of the increasingly cross-disciplinary nature of research. Examples of increased funding for centers and group activities include: Approximately $1.5 million for multi-user instrumentation in the life sciences; and $2.0 million for installation of on-line research networks in the ecological sciences at the Long Term Ecological Research sites (LTERs).

Sustaining recent progress in the life sciences requires increased focus on the development of human resources and education. Approximately $7.0 million of the BBS requested increase will be available for these activities. A new initiative is planned in course curriculum development, integrating introductory-level courses in modern biology with other disciplines. Opportunities for mid-career training in the latest research techniques will also be emphasized.

Computer and Information Science and Engineering

The FY 1990 Budget Request for Computer and Information Science and Engineering is $191.20 million, or $39.12 million (25.7 percent) over the FY 1989 Current Plan of $152.08 million.

The FY 1990 CISE program will place more emphasis on research in such areas as Very Large Scale Integration (VLSI) based computers and prototyping; computer vision and speech; software systems and engineering; and various networking projects. The Request includes increases totalling approximately $10 million for individual and group projects in these areas.

As in FY 1989, CISE will increase activity in advanced scientific computing and networking. The request includes an increase of $15.0 million for maintaining and upgrading hardware and supporting systems at the five supercomputer centers and an increase of $5.0 million for expanding and improving NSFNET operations and services.

In the area of education and human resources, CISE will provide a $6.0 million increase for undergraduate programs in VLSI design and network servicing, for minority infrastructure building, and for education infrastructure building in computer and information fields.

Engineering

The FY 1990 Budget Request for the Engineering (ENG) Activity is $211.2 million, an increase of $23.94 million (12.8 percent) over the FY 1989 Current Plan of $187.26 million.

The support of individual investigator research continues to be a major emphasis and top priority, accounting for almost half of the total ENG budget. The FY 1990 request provides a $5.5 million increase over the FY 1989 base of $98.2 million for grants in such high priority areas as microscale chemical processing, small electromechanical and electronic devices, downstream biochemical processing, and optical high-speed communications.

The Engineering Research Centers program will increase by $7.65 million to $45.7 million in FY 1990, an increase of 20 percent. The increase will allow about three new centers to be started. The Industry/University Cooperative Research Centers program is increased by $1.4 million from $3.6 million to $5.0 million to increase the average support of IUCRCs to about $75K/year and to initiate new centers to address emerging technological opportunities.

Programs aimed at revitalizing the engineering undergraduate educational enterprise will more than double from $6.9 to $14.9 million in FY 1990. This includes $4.0 million to develop model undergraduate engineering curricula; $2.0 million for the Research Experiences for Undergraduates program; and increases for the NSF-wide

Instrumentation and Laboratory Improvement and Research in Undergraduate Institutions programs.

Geosciences

The FY 1990 Budget Request for Geosciences (GEO) is $341.30 million, an increase of $31.02 million, or 10.0 percent over the current plan of $310.28 million.

The principal focus of the Geosciences Activity is the Global Geosciences Program, an interrelated set of programs which seeks to understand, and ultimately predict, global atmospheric, oceanic, and geologic processes. The Global Geosciences Program is a major contributor to the government-wide Global Change initiative. Global Geosciences includes support for specialized facilities, as well as individual investigators and groups. Funding for the Global Geosciences Program will increase by $12.5 million to $45.7 million, with an emphasis on the collection of observational data for use in models of atmospheric and ocean processes.

Support for individual investigator research and the requisite facilities for conducting laboratory studies, field experiments, and modeling activities will increase by $19.58 million, to $270.45 million. This includes support for facilities such as the National Center for Atmospheric Research and the academic research fleet. Earth sciences instrumentation will also be increased. These major facilities are key to research in the Geosciences and are used by scientists funded through NSF as well as through other federal agencies.

Because of the interdisciplinary nature of the geosciences, center and group activities will become increasingly important. Funding for groups and centers, including the Continental Lithosphere Program, Ocean Drilling Program, and group activities related to the Global Geosciences Program will increase by $8.44 million, to $60.14 million.

The GEO activity will continue to increase support for programs to improve research opportunities for young investigators and to attract graduate and undergraduate students and minorities to the geosciences. Support for undergraduate activities increases by $3.0 million, including increments for the Research Experiences for Undergraduates program, faculty enhancement at primarily undergraduate institutions, and undergraduate minority programs.

Mathematical and Physical Sciences

The FY 1990 Budget Request for Mathematical and Physical Sciences (MPS) is $553.50 million, an increase of $50.25 million (10.0 percent) over the FY 1989 Current Plan of $503.25 million.

The FY 1990 program in MPS highlights research across all MPS disciplines. Increased support for materials research focuses on superconductivity, semiconductors,

biomaterials and materials chemistry. Support for superconductivity research will increase by over $2.0 million for a total of over $25.0 million. Growth in theoretical physics addresses complex systems and chaos. Special attention is given to the expansion of modern geometric ideas throughout mathematics, and to collaborative research involving mathematics and other science and engineering disciplines.

Support continues for major national facilities and centers. A new High Magnetic Field Facility is planned, providing unique research opportunities across the physical and biological sciences. The FY 1990 Request includes $12.0 million to begin construction after an open competition and a late FY 1990 award. Construction is estimated to cost $100 million over five years, half of which would come from federal funds.

Enhancements are provided for operations at physics facilities where upgrades were recently completed. Construction continues on the Very Long Baseline Array radio telescope. Six Science and Technology Centers ($14.8 million), addressing research issues ranging from particle astrophysics to cement-based materials, move into their second year.

An additional $12.0 million will be provided in FY 1990 for efforts aimed at strengthening human resources, which will emphasize undergraduate research and education. Growth is planned for activities involving research experiences for undergraduates, instructional instrumentation, course and curriculum development, and programs to increase the participation of underrepresented groups. Special postdoctoral programs in chemistry and mathematics receive increases, and support for Presidential Young Investigators continues.

Science and Technology Research Centers

The FY 1990 Request for the Science and Technology Research Centers (STC) Activity is $20.0 million to fund a second "class" of eight to ten STCs. Funding for the recently announced awards is included with the responsible Activity.

The first STC competition demonstrated that many more areas of excellent multidisciplinary, multi-institutional research would benefit from the center mode than could be funded. While 11 centers were recently selected for funding, a significant number of highly meritorious proposals could not be funded.

A second competition will enable the center mode of research to expand to these exciting and challenging areas of science and engineering research and education.

Scientific, Technological, and International Affairs

The FY 1990 Request for the Scientific, Technological, and International Affairs activity is $67.32 million or 15.4 percent above the FY 1989 Current Plan of $58.33 million.

STIA's activities cut across scientific and engineering disciplines in the Foundation, often responding to special executive and legislative mandates. In addition, STIA serves as a management focal point for many of the cross disciplinary programs which are funded by research activities in NSF.

Nearly one-half of the total STIA budget is expected to support individual investigators in FY 1990. Awards meet dual objectives of supporting high quality research and promoting S&T activities in special settings such as small high technology companies and the international community.

Awards under the Small Business Innovation Research (SBIR) Program will increase by over $2.6 million and provide $21.46 million to small R&D and product based companies to perform research possibly leading to more rapid commercialization of new high technology products and processes.

The Request includes an increase of almost $1.0 million to $12.27 million for International Cooperative Scientific activities. In addition to continued support for individual investigator awards for high quality research programs, special attention will be given to dissemination and analysis of international scientific and technical information and to increased U.S. participation in research within Japanese academic and industrial laboratories.

Research Initiation and Improvement programs increase by $3.7 million from $23.0 million to $26.7 million. These programs support efforts to increase research participation by underrepresented groups and to improve research infrastructure at minority institutions. The Research Careers for Minority Scholars Program will be increased by $1.5 million, from $2.0 million to $3.5 million. This initiative, which was begun in FY 1989, is aimed at encouraging talented undergraduate students to begin and continue studies leading to careers in science and engineering.

The Experimental Program to Stimulate Competitive Research (EPSCoR) will receive $10.0 million, an increase of $2.0 million, to assist states in building local resources for science and engineering.

Intramural analyses and other data collection activities will be increased by $1.7 million from $4.3 million to $6.0 million. These activities provide the quantitative basis for monitoring the nation's science and engineering infrastructure. Increases will permit redesign of systems that generate data on scientific personnel and improvements in data collection on the nation's undergraduate educational system.

Program Development and Management

The Program Development and Management (PD&M) Activity increases by $12.4 million to $104.0 million, a 13.5 percent increase over the FY 1989 Current Plan.

This activity accounts for only 4.8% of the Foundation's total FY 1990 request. It provides funds for staff salaries and other operating expenses necessary to manage and administer the Foundation's program responsibilities.

The increase in PD&M includes:

- $4.4 million for personnel compensation and benefits necessary to cover the cost of the January 1989 government-wide pay raise and support the requested increase to 1230 FTE staff years.

- $4.8 million for information systems, including $1.8 million to support the conversion of management systems to the mainframe computer installed during 1988. Funds are also requested to upgrade in-house printing capability, and to begin the replacement cycle for personal computer workstations.

- $2.1 million to maintain current levels of essential contract services including mail and warehouse facilities, building rental and maintenance, and certain relocation expenses.

- $1.1 million to fund increased levels of support services associated with programmatic growth, including travel,training, and printing.

## SCIENCE AND ENGINEERING EDUCATION

The FY 1990 Budget Request for Science and Engineering Education (SEE) is $190.0 million or $19.0 million (11.1 percent) over the FY 1988 Current Plan of $171.1 million.

Funds for pre-college science and mathematics education increase $10.0 million, or 8.4 percent, over FY 1989, to total $129.0 million. This provides continued support for teacher preparation and enhancement, materials development, informal science education, and the young scholars program. Special attention will be given to much-needed mathematics curriculum reform at the middle school level. The Presidential Awards for Excellence in Science and Mathematics Teaching will expand to include elementary-level teachers, as well as middle- and secondary-level teachers.

Within the SEE Activity, undergraduate programs continue to receive focused attention through the Undergraduate Science, Engineering and Mathematics Education (USEME) Subactivity. SEE's support for undergraduate education has been increased in FY 1990 over FY 1989 ($2.0 million; 7.1 percent). The Career Access Opportunities for Women, Minorities and the Disabled program is being enhanced to establish two additional

Comprehensive Regional Centers for Minorities.

The number of new Graduate Fellowships will be increased from 860 in FY 1989 to 960 in FY 1990, for a total of nearly 2280 new and continuing Fellows supported. In addition, the stipend will be increased from $12,300 to $12,900 per year. A new Women in Engineering component of the program will support 80 Fellows, 40 by SEE and 40 by the Engineering Activity. The increment to support these programmatic changes is $7.0 million.

## UNITED STATES ANTARCTIC PROGRAM

The FY 1990 Budget Request for the U.S. Antarctic Program (USAP) is $156.0 million, an increase of $24.85 million or 18.9% over the FY 1989 Current Plan of $131.15 million.

The antarctic area is of considerable scientific interest and significance in understanding several key global phenomena. One ongoing concern of global significance is the seasonal depletion of ozone over the Antarctic. Support for Antarctic research increases by $2.0 million, to $17.5 million. Included in the request are funds for continued ultra-violet (UV) monitoring, and research on the effects of UV radiation on biological systems.

The request includes $10.0 million as initial funding for a major, multi-year initiative in safety, health, and environmental protection. A number of major safety and health improvement needs and environmental matters will be addressed, such as waste management and disposal, environmental monitoring, air traffic control facilities, communications reliability, and clean-up of past operations. A comprehensive approach to improvements in these areas is needed in order to deal with the significant problems that have accumulated.

Funds are requested ($4.2 million) toward acquisition of a research vessel with icebreaking capability.

## DISTRIBUTED AND SPECIAL FOCUS PROGRAMS

The Foundation has developed several programs to strengthen the research infrastructure and develop human resources for science and engineering. All science and engineering research and education Activities provide support under these umbrella efforts. Management of the programs is distributed, and closely coupled with the ongoing functions and responsibilities of each Activity. In this way, concerns are addressed in the context of discipline-specific problems and needs.

The FY 1990 Request includes $104.90 million for undergraduate research and education, $40.50 million (62.9 percent) over the FY 1989 target. In addition, support of the ongoing program of research at Predominantly Undergraduate Institutions (PUI) will

increase by $4.00 million. The undergraduate plan is a comprehensive NSF-wide approach to the problems of undergraduate education and is based on the needs of individual disciplines as well as broader educational issues. The undergraduate initiative, which began in FY 1987, includes support for student research, faculty enhancement, course and curriculum development, and instructional instrumentation.

Within overall NSF efforts to broaden participation in science and engineering, underrepresented groups receive additional attention. Focus is on women, minorities, and the disabled. This effort involves not only distributed programs, such as Minority Research Initiation (MRI) and Research Opportunities for Women (ROW), but also targeted programs, such as Research In Minority Institutions (RIMI), Minority Research Centers of Excellence (MRCE), Research Careers for Minority Scholars (RCMS) and Visiting Professorships for Women (VPW) in the STIA Activity and Career Access in the SEE Activity. An expanded Experimental Program to Stimulate Competitive Research (EPSCoR) increases to $10.00 million in the FY 1990 Request. The FY 1990 Request includes $58.69 million for this set of programs, $9.45 million (19.2 percent) over the FY 1989 target.

## EXPLANATION OF CARRYOVER

In addition to the FY 1989 appropriations, unobligated balances totalling $813 thousand are available for obligation in FY 1989. The sources of these funds are:

- The unobligated balance $616 thousand from the FY 1988 Research and Related Activities Appropriation consists of $545 thousand of IIASA funds not awarded and unavailable for use because of a legislative limitation and of funds in several Activities which, for procedural reasons, could not be obligated by the end of FY 1988.

- The unobligated balance of the FY 1988 Science and Engineering Education Activities Appropriation is $44 thousand and results from small carryover balances in each of the five Subactivities, the largest part due to uncertainty over the number of Presidential Awards for Teaching Excellence which are normally awarded at the end of the fiscal year. The unobligated funds will be used in FY 1989 for the activities planned in FY 1988.

- A balance of $153 thousand from the United States Antarctic Appropriation remained unobligated at the end of FY 1988. This balance will be available for use during FY 1989.

## BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES: FY 1990/FY 1989 (Dollars in Thousands)

| | Actual FY 1988 | Request FY 1989 | Current Plan FY 1989 | Estimate FY 1990 | Difference FY 1990/1989 Amount | Difference FY 1990/1989 Percent |
|---|---|---|---|---|---|---|
| **BIOLOGICAL, BEHAVIORAL & SOCIAL SCIENCES** | | | | | | |
| Molecular Biosciences | 844,493 | 847,706 | 846,573 | 931,380 | 84,807 | 10.3% |
| Cellular Biosciences | 53,877 | 56,930 | 55,590 | 60,580 | 4,990 | 9.0% |
| Biotic Systems and Resources | 58,659 | 64,431 | 62,889 | 76,010 | 13,121 | 20.9% |
| Behavioral and Neural Sciences | 43,390 | 43,900 | 44,814 | 48,280 | 3,466 | 7.7% |
| Social and Economic Science | 30,104 | 33,194 | 30,888 | 33,220 | 2,332 | 7.5% |
| Instrumentation and Resources | 34,357 | 38,430 | 36,626 | 40,030 | 3,404 | 9.3% |
| Science and Technology Centers | 0 | 0 | 4,130 | 5,000 | 850 | 20.5% |
| Total, BBS | 265,080 | 285,581 | 281,530 | 314,500 | 32,970 | 11.7% |
| **COMPUTER AND INFORMATION SCIENCE AND ENGINEERING** | | | | | | |
| Computer and Computation Research | 19,848 | 22,167 | 21,148 | 23,673 | 2,525 | 11.9% |
| Information Robotics and Intelligent Systems | 17,732 | 19,727 | 19,117 | 21,637 | 2,520 | 13.2% |
| Microelectronic Information Processing Systems | 13,286 | 15,904 | 14,962 | 18,952 | 3,990 | 26.7% |
| Advanced Scientific Computing | 44,702 | 59,829 | 59,829 | 71,689 | 15,860 | 28.4% |
| Networking and Communications Research and Infrastructure | 11,474 | 17,683 | 17,683 | 27,133 | 9,450 | 53.4% |
| Cross-Disciplinary Activities | 16,871 | 17,416 | 17,416 | 21,416 | 4,000 | 23.0% |
| Science and Technology Centers | 0 | 0 | 5,925 | 6,700 | 775 | 13.1% |
| Total, CISE | 123,913 | 148,726 | 152,080 | 191,200 | 39,120 | 25.7% |
| **ENGINEERING** | | | | | | |
| Chemical and Thermal Systems | 31,610 | 34,496 | 33,196 | 35,912 | 2,716 | 8.2% |
| Mechanical and Structural Systems | 23,670 | 26,225 | 24,715 | 26,778 | 2,063 | 8.3% |
| Electrical and Communications Systems | 28,957 | 32,606 | 31,793 | 36,040 | 4,247 | 13.4% |
| Design and Manufacturing Systems | 17,660 | 20,011 | 19,280 | 21,850 | 2,570 | 13.3% |
| Biological and Critical Systems | 33,787 | 37,774 | 36,639 | 39,920 | 3,281 | 9.0% |
| Engineering Centers | 36,391 | 43,225 | 41,638 | 50,700 | 9,062 | 21.8% |
| Total, ENG. | 172,075 | 194,327 | 187,261 | 211,200 | 23,939 | 12.8% |
| **GEOSCIENCES** | | | | | | |
| Atmospheric Sciences | 98,154 | 103,975 | 98,726 | 109,440 | 10,714 | 10.9% |
| Earth Sciences | 51,262 | 59,120 | 56,159 | 65,160 | 11,001 | 20.3% |
| Ocean Sciences | 134,946 | 146,120 | 146,173 | 152,880 | 6,707 | 4.6% |
| Arctic Research Program | 8,293 | 10,810 | 10,324 | 12,820 | 2,496 | 24.2% |
| Science and Technology Centers | 0 | 0 | 900 | 1,000 | 100 | 11.1% |
| Total, GEO | 290,655 | 320,025 | 310,282 | 341,300 | 31,018 | 10.0% |
| **MATHEMATICAL AND PHYSICAL SCIENCES** | | | | | | |
| Mathematical Sciences | 63,763 | 67,591 | 65,873 | 76,046 | 10,173 | 15.4% |
| Astronomical Sciences | 85,788 | 89,501 | 89,518 | 94,018 | 4,500 | 5.0% |
| Physics | 117,896 | 125,961 | 122,558 | 129,998 | 7,440 | 6.1% |
| Chemistry | 94,028 | 98,571 | 96,628 | 103,428 | 6,800 | 7.0% |
| Materials Research | 110,556 | 118,181 | 114,977 | 135,177 | 20,200 | 17.6% |
| Science and Technology Centers | 0 | 0 | 13,699 | 14,833 | 1,134 | 8.3% |
| Total, MPS | 472,031 | 499,805 | 503,253 | 553,500 | 50,247 | 10.0% |
| **PROGRAM DEVELOPMENT AND MANAGEMENT** | 84,466 | 95,550 | 91,650 * | 104,000 | 12,350 | 13.5% |
| **SCIENCE AND TECHNOLOGY CENTERS** | 0 | 30,000 | 326 | 20,000 | 19,674 | N/A |

*Upon approval of the requested increase in the FY 1989 PD&M limitation, $1,100,000 will be transferred to the PD&M activity for cost increases resulting from the 1989 government-wide pay adjustment. Proportional reductions will be made in all other Research and Related Activities to accomodate this transfer.

## BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES: FY 1990/FY 1989 (Dollars in Thousands)

| | Actual FY 1988 | Request FY 1989 | Current Plan FY 1989 | Estimate FY 1990 | Difference FY 1990/1989 Amount | Difference FY 1990/1989 Percent |
|---|---|---|---|---|---|---|
| **SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS** | | | | | | |
| Industrial Science and Technological Innovation | $17,370 | $19,037 | $18,853 | $21,460 | $2,607 | 13.8% |
| International Cooperative Scientific Activities | 10,661 | 11,549 | 11,283 | 12,272 | 989 | 8.8% |
| Policy Research and Analysis | 853 | 948 | 850 | 850 | 0 | 0.0% |
| Science Resources Studies | 4,006 | 4,509 | 4,305 | 6,000 | 1,695 | 39.4% |
| Research Initiation and Improvement | 17,162 | 23,043 | 23,043 | 26,740 | 3,697 | 16.0% |
| Total, STIA | 50,052 | 59,986 | 58,334 | 67,322 | 8,988 | 15.4% |
| TOTAL, RESEARCH AND RELATED ACTIVITIES | 1,458,272 | 1,633,000 | 1,584,716 | 1,803,022 | 218,306 | 13.8% |
| **SCIENCE AND ENGINEERING EDUCATION** | | | | | | |
| Teacher Preparation and Enhancement | 45,532 | 53,500 | 63,525 | 68,500 | 4,975 | 7.8% |
| Materials Development, Research and Informal Science Education | 37,810 | 43,500 | 44,002 | 49,000 | 4,998 | 11.4% |
| Undergraduate Science, Engineering and Mathematics Education | 19,026 | 23,500 | 28,001 | 30,000 | 1,999 | 7.1% |
| Research Career Development | 34,021 | 31,000 | 31,016 | 38,000 | 6,984 | 22.5% |
| Studies and Program Assessment | 3,240 | 4,500 | 4,500 | 4,500 | 0 | 0.0% |
| Total, SEE | 139,629 | 156,000 | 171,044 | 190,000 | 18,956 | 11.1% |
| **U.S. ANTARCTIC PROGRAM** | | | | | | |
| U.S. Antarctic Research Program | 13,522 | 15,500 | 15,500 | 17,500 | 2,000 | 12.9% |
| Antarctic Operations Program | 85,243 | 92,200 | 87,353 | 102,200 | 14,847 | 17.0% |
| Major Construction and Procurement | 25,900 | 33,300 | 28,300 | 36,300 | 8,000 | 28.3% |
| Total, USAP | 124,665 | 141,000 | 131,153 | 156,000 | 24,847 | 18.9% |
| Proposed Supplemental to Increase PD&M Limitation | 0 | 0 | (1,100)* | 0 | 1,100 | -100.0% |
| TOTAL, NATIONAL SCIENCE FOUNDATION | $1,722,566 | $1,930,000 | $1,885,813 | $2,149,022 | $263,209 | 14.0% |

*Upon approval of the requested increase in the FY 1989 PD&M limitation, $1,100,000 will be transferred to the PD&M activity for cost increases resulting from the 1989 government-wide pay adjustment. Proportional reductions will be made in all other Research and Related Activities to accomodate this transfer.

## *SUMMARY BUDGET INFORMATION BY SUBACTIVITY, ACTIVITY AND APPROPRIATION: FY 1988-FY 1990 (Dollars in Thousands)*

| | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| RESEARCH AND RELATED ACTIVITIES | | | | | |
| Biological, Behavioral and Social Sciences | $265,080 | $285,581 | $281,530 | $314,500 | $32,970 |
| Computer and Information Science and Engineering | 123,913 | 148,726 | 152,080 | 191,200 | 39,120 |
| Engineering | 172,075 | 194,327 | 187,261 | 211,200 | 23,939 |
| Geosciences | 290,655 | 320,025 | 310,282 | 341,300 | 31,018 |
| Mathematical and Physical Sciences | 472,031 | 499,805 | 503,253 | 553,500 | 50,247 |
| Program Development and Management | 84,466 | 95,550 | 91,650 * | 104,000 | 12,350 |
| Science and Technology Centers | 0 | 30,000 | 326 | 20,000 | 19,674 |
| Scientific, Technological and International Affairs | 50,052 | 58,986 | 58,334 | 67,322 | 8,988 |
| Subtotal | 1,458,272 | 1,633,000 | 1,584,716 | 1,803,022 | 218,306 |
| Unobligated Balance and Other Adjustments | (5,272) | -0- | (616) | -0- | 616 |
| Proposed Supplemental to Increase PD&M Limitation | 0 | -0- | (1,100) * | -0- | 1,100 |
| Research and Related Activities Appropriation | 1,453,000 | 1,633,000 | 1,583,000 | 1,803,022 | 220,022 |
| SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION | | | | | |
| Teacher Preparation and Enhancement | 45,532 | 53,500 | 63,525 | 68,500 | 4,975 |
| Materials Development, Research and Informal Science Education | 37,810 | 43,500 | 44,002 | 49,000 | 4,998 |
| Undergraduate Science, Engineering and Mathematics Education | 19,026 | 23,500 | 28,001 | 30,000 | 1,999 |
| Research Career Development | 34,021 | 31,000 | 31,016 | 38,000 | 6,984 |
| Studies and Program Assessment | 3,240 | 4,500 | 4,500 | 4,500 | 0 |
| Subtotal, Obligations | 139,629 | 156,000 | 171,044 | 190,000 | 18,956 |
| Unobligated Balance and Other Adjustments | (429) | -0- | (44) | -0- | 44 |
| Science and Engineering Education Activities Appropriation | 139,200 | 156,000 | 171,000 | 190,000 | 19,000 |
| U.S. ANTARCTIC RESEARCH PROGRAM | | | | | |
| U.S. Antarctic Research Program | 13,522 | 15,500 | 15,500 | 17,500 | 2,000 |
| Antarctic Operations Program | 85,243 | 92,200 | 87,353 | 102,200 | 14,847 |
| Major Construction and Procurement | 25,900 | 33,300 | 28,300 | 36,300 | 8,000 |
| Subtotal, Obligations | 124,665 | 141,000 | 131,153 | 156,000 | 24,847 |
| Unobligated Balance and Other Adjustments | 135 | -0- | (153) | -0- | 153 |
| U.S. Antarctic Program Appropriation | 124,800 | 141,000 | 131,000 | 156,000 | 25,000 |
| TOTAL, NSF APPROPRIATION | $1,717,000 | $1,930,000 | $1,885,000 | $2,149,022 | $264,022 |

*Upon approval of the requested increase in the FY 1989 PD&M limitation, $1,100,000 will be transferred to the PD&M activity for cost increases resulting from the 1989 government-wide pay adjustment. Proportional reductions will be made in all other Research and Related Activities to accomodate this transfer.

## LEVEL OF FUNDING BY PROGRAM

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| BIOLOGICAL, BEHAVIORAL, AND, SOCIAL SCIENCES | | | | | |
| MOLECULAR BIOSCIENCES | | | | | |
| Biochemistry | $13,212 | $13,702 | $13,470 | $14,500 | $1,030 |
| Biophysics | 13,673 | 14,650 | 14,294 | 15,940 | 1,646 |
| Genetics | 17,608 | 19,354 | 18,809 | 20,940 | 2,131 |
| Total | 44,493 | 47,706 | 46,573 | 51,380 | 4,807 |
| CELLULAR BIOSCIENCES | | | | | |
| Cell Biology | 15,647 | 16,405 | 15,854 | 17,368 | 1,514 |
| Cellular Biochemistry | 11,514 | 11,855 | 11,855 | 12,691 | 836 |
| Developmental Biology | 12,780 | 14,418 | 13,918 | 14,838 | 920 |
| Physiological Processes | 13,936 | 14,252 | 13,963 | 15,683 | 1,720 |
| Total | 53,877 | 56,930 | 55,590 | 60,580 | 4,990 |
| BIOTIC SYSTEMS AND RESOURCES | | | | | |
| Ecology | 9,685 | 9,975 | 9,975 | 12,430 | 2,455 |
| Ecosystem Studies | 20,158 | 25,008 | 23,466 | 27,330 | 3,864 |
| Systematic Biology | 12,395 | 12,725 | 12,725 | 15,920 | 3,195 |
| Population Biology and Physiological Ecology | 10,151 | 10,448 | 10,448 | 12,960 | 2,512 |
| Biological Research Resources | 6,270 | 6,275 | 6,275 | 7,370 | 1,095 |
| Total | 58,659 | 64,431 | 62,889 | 76,010 | 13,121 |
| BEHAVIORAL AND NEURAL SCIENCES | | | | | |
| Anthropology | 7,496 | 7,920 | 7,727 | 8,000 | 273 |
| Language, Cognition and Social Behavior | 9,338 | 9,720 | 9,501 | 10,200 | 699 |
| Biological Basis of Behavior | 11,015 | 11,910 | 11,622 | 12,950 | 1,328 |
| Neuroscience | 15,741 | 16,350 | 15,964 | 17,130 | 1,166 |
| Total | 43,590 | 45,900 | 44,814 | 48,280 | 3,466 |
| SOCIAL AND ECONOMIC SCIENCE | | | | | |
| Economics | 12,728 | 12,772 | 12,886 | 13,886 | 1,000 |
| Geography | 2,659 | 3,175 | 2,945 | 3,195 | 250 |
| Sociology | 3,719 | 4,250 | 3,720 | 4,170 | 450 |
| Measurement Methods and Data Improvement | 2,376 | 2,575 | 2,375 | 2,375 | 0 |
| Political Science | 3,939 | 4,050 | 3,780 | 3,980 | 200 |
| Law and Social Sciences | 1,915 | 2,315 | 1,915 | 2,107 | 192 |
| Decision, Risk and Management Science | 2,768 | 3,057 | 3,267 | 3,507 | 240 |
| Total | 30,104 | 32,194 | 30,888 | 33,220 | 2,332 |
| INSTRUMENTATION AND RESOURCES | | | | | |
| Instrumentation and Instrument Development | 16,033 | 17,000 | 16,600 | 18,100 | 1,500 |
| Special Projects | 16,255 | 19,140 | 17,776 | 19,430 | 1,654 |
| Studies in Science and Technology | 2,069 | 2,280 | 2,250 | 2,500 | 250 |
| Total | 34,357 | 38,420 | 36,626 | 40,030 | 3,404 |
| SCIENCE AND TECHNOLOGY CENTERS | | | | | |
| Science and Technology Centers | 0 | 0 | 4,150 | 5,000 | 850 |
| TOTAL, BBS | $265,080 | $285,581 | $281,530 | $314,500 | $32,970 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| COMPUTER AND INFORMATION SCIENCE AND ENGINEERING | | | | | |
| COMPUTER AND COMPUTATION RESEARCH | | | | | |
| Computer and Computation Theory | $6,045 | $6,559 | $6,419 | $6,719 | $300 |
| Numeric and Symbolic Computation | 2,416 | 3,072 | 2,826 | 2,951 | 125 |
| Computer Systems Architecture | 3,119 | 3,090 | 3,095 | 3,595 | 500 |
| Software Systems | 5,708 | 6,214 | 6,070 | 6,870 | 800 |
| Software Engineering | 2,560 | 3,232 | 2,730 | 3,538 | 800 |
| Total | 19,848 | 22,167 | 21,140 | 23,673 | 2,525 |
| INFORMATION, ROBOTICS AND INTELLIGENT SYSTEMS | | | | | |
| Knowledge and Database Systems | 7,390 | 8,300 | 7,673 | 8,213 | 540 |
| Robotics and Machine Intelligence | 5,446 | 6,111 | 6,030 | 6,770 | 740 |
| Interactive Systems | 2,484 | 2,733 | 2,657 | 3,387 | 730 |
| Information Technology and Organizations | 2,412 | 2,583 | 2,757 | 3,267 | 510 |
| Total | 17,732 | 19,727 | 19,117 | 21,637 | 2,520 |
| MICROELECTRONIC INFORMATION PROCESSING SYSTEMS | | | | | |
| Design, Tools and Test | 2,793 | 3,031 | 2,985 | 3,295 | 310 |
| Microelectronic Systems Architecture | 2,571 | 2,983 | 2,667 | 3,087 | 420 |
| Circuits and Signal Processing | 3,187 | 3,428 | 3,413 | 3,783 | 370 |
| Experimental Systems | 3,249 | 4,174 | 4,080 | 6,080 | 2,000 |
| Systems Prototyping and Fabrication | 1,486 | 2,288 | 1,817 | 2,707 | 890 |
| Total | 13,286 | 15,904 | 14,962 | 18,952 | 3,990 |
| ADVANCED SCIENTIFIC COMPUTING | | | | | |
| Supercomputer Centers | 42,936 | 54,028 | 54,028 | 69,028 | 15,000 |
| New Technologies | 1,766 | 1,801 | 1,801 | 2,661 | 860 |
| Total | 44,702 | 55,829 | 55,829 | 71,689 | 15,860 |
| NETWORKING AND COMMUNICATIONS RESEARCH AND INFRASTRUCTURE | | | | | |
| NSFNET | 7,730 | 13,632 | 13,632 | 19,632 | 6,000 |
| Networking and Communications Research | 3,744 | 4,051 | 4,051 | 7,501 | 3,450 |
| Total | 11,474 | 17,683 | 17,683 | 27,133 | 9,450 |
| CROSS-DISCIPLINARY ACTIVITIES | | | | | |
| CISE Institutional Infrastructure | 14,607 | 14,928 | 14,928 | 18,928 | 4,000 |
| CISE Instrumentation | 2,264 | 2,488 | 2,488 | 2,488 | 0 |
| Total | 16,871 | 17,416 | 17,416 | 21,416 | 4,000 |
| SCIENCE AND TECHNOLOGY CENTERS | | | | | |
| Science and Technology Centers | 0 | 0 | 5,925 | 6,700 | 775 |
| TOTAL, CISE | $123,913 | $148,726 | $152,080 | $191,200 | $39,120 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| ENGINEERING | | | | | |
| CHEMICAL AND THERMAL SYSTEMS | | | | | |
| Chemical Reaction Processes | $6,702 | $7,486 | $7,016 | $7,380 | $364 |
| Interfacial, Transport and Separations Processes | 7,784 | 8,880 | 8,660 | 9,850 | 1,190 |
| Thermal Systems | 8,151 | 8,452 | 8,252 | 8,767 | 515 |
| Fluid, Particulate and Hydraulic Systems | 8,893 | 9,668 | 9,268 | 9,915 | 647 |
| Total | 31,610 | 34,486 | 33,196 | 35,912 | 2,716 |
| MECHANICAL AND STRUCTURAL SYSTEMS | | | | | |
| Dynamic Systems and Control | 3,197 | 3,388 | 3,388 | 3,690 | 302 |
| Structures and Building Systems | 7,008 | 7,655 | 7,225 | 7,878 | 653 |
| Materials Engineering and Tribology | 7,145 | 8,094 | 7,524 | 8,130 | 606 |
| Solid and Geomechanics | 6,320 | 7,088 | 6,578 | 7,080 | 502 |
| Total | 23,670 | 26,225 | 24,715 | 26,778 | 2,063 |
| ELECTRICAL AND COMMUNICATIONS SYSTEMS | | | | | |
| Quantum Electronics, Waves and Beams | 8,196 | 8,630 | 8,520 | 9,800 | 1,280 |
| Solid State and Microstructures | 7,362 | 7,625 | 7,625 | 8,200 | 575 |
| Communications and Computational Systems | 6,515 | 7,835 | 7,245 | 8,240 | 995 |
| Engineering Systems | 5,884 | 6,521 | 6,408 | 6,800 | 392 |
| Emerging Technologies Initiation | 1,000 | 1,995 | 1,995 | 3,000 | 1,005 |
| Total | 28,957 | 32,606 | 31,793 | 36,040 | 4,247 |
| DESIGN AND MANUFACTURING SYSTEMS | | | | | |
| Operations Research and Production Systems | 4,518 | 4,910 | 4,853 | 5,765 | 912 |
| Design and Computer-Integrated Engineering | 5,998 | 6,938 | 6,553 | 7,190 | 637 |
| Manufacturing Processes and Equipment | 7,144 | 8,163 | 7,874 | 8,895 | 1,021 |
| Total | 17,660 | 20,011 | 19,280 | 21,850 | 2,570 |
| BIOLOGICAL AND CRITICAL SYSTEMS | | | | | |
| Bioengineering and Aiding the Disabled | 11,765 | 12,958 | 12,323 | 13,800 | 1,477 |
| Environmental and Ocean Systems | 4,076 | 5,770 | 5,680 | 6,120 | 440 |
| Earthquake Hazard Mitigation | 15,346 | 16,166 | 15,896 | 17,000 | 1,104 |
| Natural and Man-Made Hazard Mitigation | 2,600 | 2,880 | 2,740 | 3,000 | 260 |
| Total | 33,787 | 37,774 | 36,639 | 39,920 | 3,281 |
| ENGINEERING CENTERS | | | | | |
| Engineering Research Centers | 33,259 | 39,870 | 38,048 | 45,700 | 7,652 |
| Industry/University Cooperative Research Centers | 3,132 | 3,355 | 3,590 | 5,000 | 1,410 |
| Total | 36,391 | 43,225 | 41,638 | 50,700 | 9,062 |
| TOTAL, ENGINEERING | $172,075 | $194,327 | $187,261 | $211,200 | $23,939 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| **GEOSCIENCES** | | | | | |
| **ATMOSPHERIC SCIENCES** | | | | | |
| Atmospheric Sciences Project Support | $48,652 | $52,475 | $49,626 | $55,230 | $5,604 |
| National Center for Atmospheric Research | 42,760 | 46,110 | 44,090 | 48,250 | 4,160 |
| Upper Atmospheric Facilities | 4,742 | 5,390 | 5,010 | 5,960 | 950 |
| Total | 96,154 | 103,975 | 98,726 | 109,440 | 10,714 |
| **EARTH SCIENCES** | | | | | |
| Earth Sciences Project Support | 35,396 | 38,360 | 36,579 | 42,320 | 5,741 |
| Instrumentation and Facilities | 5,188 | 6,000 | 5,540 | 6,800 | 1,260 |
| Continental Lithosphere | 10,678 | 14,760 | 12,040 | 16,040 | 4,000 |
| Total | 51,262 | 59,120 | 54,159 | 65,160 | 11,001 |
| **OCEAN SCIENCES** | | | | | |
| Ocean Sciences Research Support | 67,173 | 72,910 | 71,213 | 74,660 | 3,447 |
| Oceanographic Centers and Facilities | 37,162 | 41,200 | 43,590 | 45,330 | 1,740 |
| Ocean Drilling Program | 30,611 | 32,010 | 31,370 | 32,890 | 1,520 |
| Total | 134,946 | 146,120 | 146,173 | 152,880 | 6,707 |
| **ARCTIC RESEARCH PROGRAM** | | | | | |
| Arctic Research Projects | 7,813 | 10,310 | 9,824 | 12,320 | 2,496 |
| Arctic Research Commission | 480 | 500 | 500 | 500 | 0 |
| Total | 8,293 | 10,810 | 10,324 | 12,820 | 2,496 |
| **SCIENCE AND TECHNOLOGY CENTERS** | | | | | |
| Science and Technology Centers | 0 | 0 | 900 | 1,000 | 100 |
| TOTAL GEOSCIENCES | $290,655 | $320,025 | $310,282 | $341,300 | $31,018 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| MATHEMATICAL AND PHYSICAL SCIENCES | | | | | |
| **MATHEMATICAL SCIENCES** | | | | | |
| Classical Analysis | 95,707 | 98,050 | 95,838 | 96,467 | 629 |
| Modern Analysis | 5,689 | 6,020 | 5,835 | 6,464 | 629 |
| Geometric Analysis | 5,849 | 6,170 | 5,924 | 7,163 | 1,239 |
| Topology and Foundations | 6,869 | 7,320 | 7,105 | 7,870 | 765 |
| Algebra and Number Theory | 9,631 | 10,200 | 9,823 | 11,149 | 1,266 |
| Applied Mathematics | 7,905 | 8,410 | 8,129 | 9,204 | 1,075 |
| Statistics and Probability | 7,038 | 7,580 | 7,229 | 8,209 | 980 |
| Computational Mathematics | 4,155 | 5,200 | 4,857 | 5,854 | 997 |
| Special Projects | 10,920 | 10,641 | 11,073 | 13,666 | 2,593 |
| Total | 63,763 | 67,591 | 65,873 | 76,046 | 10,173 |
| **ASTRONOMICAL SCIENCES** | | | | | |
| Astronomy Project Support | 28,323 | 29,031 | 29,031 | 31,231 | 2,200 |
| National Astronomy and Ionosphere Center | 5,816 | 6,240 | 6,147 | 6,347 | 200 |
| National Optical Astronomy Observatories | 23,098 | 24,220 | 24,230 | 25,230 | 1,000 |
| National Radio Astronomy Observatory | 28,551 | 30,010 | 30,110 | 31,210 | 1,100 |
| Total | 85,788 | 89,501 | 89,518 | 94,018 | 4,500 |
| **PHYSICS** | | | | | |
| Elementary Particle Physics | 41,728 | 40,434 | 40,954 | 43,434 | 2,480 |
| Intermediate Energy Nuclear Physics | 17,819 | 21,324 | 19,699 | 20,829 | 1,130 |
| Nuclear Physics | 20,955 | 23,578 | 22,667 | 23,877 | 1,210 |
| Atomic, Molecular, and Optical Physics | 13,295 | 14,275 | 13,531 | 14,421 | 890 |
| Theoretical Physics | 15,183 | 16,619 | 15,924 | 17,084 | 1,160 |
| Gravitational Physics | 8,916 | 9,731 | 9,783 | 10,353 | 570 |
| Total | 117,896 | 125,961 | 122,558 | 129,998 | 7,440 |
| **CHEMISTRY** | | | | | |
| Chemical Instrumentation | 8,400 | 8,900 | 8,400 | 8,900 | 500 |
| Organic and Macromolecular Chemistry | 22,592 | 22,810 | 23,817 | 24,968 | 1,151 |
| Physical Chemistry | 28,067 | 28,450 | 28,454 | 29,840 | 1,386 |
| Inorganic, Bioinorganic and Organometalic Chemistry | 14,220 | 14,680 | 15,959 | 16,630 | 671 |
| Analytical and Surface Chemistry | 12,049 | 12,300 | 12,719 | 13,540 | 821 |
| Special Projects | 8,700 | 11,431 | 7,279 | 9,550 | 2,271 |
| Total | 94,028 | 98,571 | 96,628 | 103,428 | 6,800 |
| **MATERIALS RESEARCH** | | | | | |
| Materials Research Project Support | 66,386 | 70,280 | 68,590 | 74,350 | 5,760 |
| Materials Research Laboratories and Groups | 33,553 | 35,771 | 34,257 | 36,197 | 1,940 |
| National Facilities | 10,617 | 12,130 | 12,130 | 24,630 | 12,500 |
| Total | 110,556 | 118,181 | 114,977 | 135,177 | 20,200 |
| **SCIENCE AND TECHNOLOGY CENTERS** | 0 | 0 | 13,699 | 14,833 | 1,134 |
| TOTAL, MPS | $472,031 | $499,805 | $503,253 | $553,500 | $50,247 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| PROGRAM DEVELOPMENT AND MANAGEMENT | | | | | |
| Program Development and Management | $84,468 | $93,330 | $91,650 * | $104,000 | $12,350 |
| Full-time Equivalent | 1,169 | 1,204 | 1,204 | 1,230 | 26 |
| SCIENCE AND TECHNOLOGY CENTERS | 0 | 30,000 | 326 | 20,000 | 19,674 |
| SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS | | | | | |
| INDUSTRIAL SCIENCE AND TECHNOLOGICAL INNOVATION | | | | | |
| Small Business Innovation Research | 17,370 | 19,037 | 18,853 | 21,460 | 2,607 |
| Total | 17,370 | 19,037 | 18,853 | 21,460 | 2,607 |
| INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES | | | | | |
| International Cooperative Science | 10,661 | 11,549 | 11,283 | 12,272 | 989 |
| Total | 10,661 | 11,549 | 11,283 | 12,272 | 989 |
| POLICY RESEARCH AND ANALYSIS | | | | | |
| Policy Research and Analysis | 853 | 848 | 850 | 850 | 0 |
| Total | 853 | 848 | 850 | 850 | 0 |
| SCIENCE RESOURCES STUDIES | | | | | |
| Studies of Science and Engineering Resources | 4,006 | 4,509 | 4,305 | 6,000 | 1,695 |
| Total | 4,006 | 4,509 | 4,305 | 6,000 | 1,695 |
| RESEARCH INITIATION AND IMPROVEMENT | | | | | |
| Individual & Group Support for Women and Minorities | 2,199 | 4,253 | 4,253 | 5,950 | 1,697 |
| Minority Institutional Development Support | 8,913 | 10,790 | 10,790 | 10,790 | 0 |
| EPSCoR | 6,050 | 8,000 | 8,000 | 10,000 | 2,000 |
| Total | 17,162 | 23,043 | 23,043 | 26,740 | 3,697 |
| TOTAL, STIA | 50,052 | 58,986 | 58,334 | 67,322 | 8,988 |
| TOTAL, RESEARCH AND RELATED ACTIVITIES | 1,458,272 | 1,633,000 | 1,584,716 | 1,803,022 | 218,306 |
| Unobligated Balances and Other Adjustments | (5,272) | 0 | (616) | 0 | 616 |
| Proposed Supplemental to Increase PD&M Limitaton | 0 | 0 | (1,100) * | 0 | 1,100 |
| Research and Related Activities Appropriation | $1,453,000 | $1,633,000 | $1,583,000 | $1,803,022 | $220,022 |

*Upon approval of the requested increase in the FY 1989 PD&M limitation, $1,100,000 will be transferred to the PD&M activity for cost increases resulting from the 1989 government-wide pay adjustment. Proportional reductions will be made in all other Research and Related Activities to accomodate this transfer.

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| SCIENCE AND ENGINEERING EDUCATION | | | | | |
| TEACHER PREPARATION AND ENHANCEMENT | | | | | |
| Science and Mathematics Education Networks | $5,974 | $9,000 | $9,000 | $10,000 | $1,000 |
| Teacher Enhancement | 32,485 | 33,200 | 43,225 | 46,000 | 2,775 |
| Presidential Awards for Excellence in Science and Mathematics Teaching | 1,287 | 1,300 | 1,830 | 2,500 | 670 |
| Teacher Preparation | 5,786 | 10,000 | 9,470 | 10,000 | 530 |
| Total | 45,532 | 53,500 | 63,525 | 68,500 | 4,975 |
| MATERIALS DEVELOPMENT, RESEARCH AND INFORMAL SCIENCE EDUCATION | | | | | |
| Applications of Advanced Technologies | 5,805 | 6,000 | 6,000 | 6,500 | 500 |
| Informal Science Education | 13,518 | 15,000 | 15,000 | 16,000 | 1,000 |
| Instructional Materials Development | 14,481 | 18,000 | 18,502 | 21,500 | 2,998 |
| Research in Teaching and Learning | 4,006 | 4,500 | 4,500 | 5,000 | 500 |
| Total | 37,810 | 43,500 | 44,002 | 49,000 | 4,998 |
| UNDERGRADUATE SCIENCE, ENGINEERING AND MATHEMATICS EDUCATION | | | | | |
| College Science Instrumentation | 11,474 | 11,500 | 16,000 | 16,000 | 0 |
| Faculty Enhancement | 3,027 | 3,000 | 3,000 | 3,000 | 0 |
| Career Access Opportunities in S&T for Women, Minorities & the Disabled | 2,540 | 5,000 | 5,000 | 7,000 | 2,000 |
| Course and Curriculum | 1,985 | 4,000 | 4,001 | 4,000 | (1) |
| Total | 19,026 | 23,500 | 28,001 | 30,000 | 1,999 |
| RESEARCH CAREER DEVELOPMENT | | | | | |
| Graduate Fellowships | 27,395 | 21,600 | 21,616 | 28,000 | 6,384 |
| Minority Graduate Fellowships | 3,000 | 2,400 | 2,400 | 3,000 | 600 |
| Young Scholars | 3,626 | 7,000 | 7,000 | 7,000 | 0 |
| Total | 34,021 | 31,000 | 31,016 | 38,000 | 6,984 |
| STUDIES AND PROGRAM ASSESSMENT | | | | | |
| Studies and Analyses | 3,240 | 4,500 | 4,500 | 4,500 | 0 |
| Total | 3,240 | 4,500 | 4,500 | 4,500 | 0 |
| TOTAL, SEE | 139,629 | 156,000 | 171,044 | 190,000 | 18,956 |
| Unobligated Balance and Other Adjustments | (429) | 0 | (44) | 0 | 44 |
| Science and Engineering Education Activities Appropriation | $139,200 | $156,000 | $171,000 | $190,000 | $19,000 |

## LEVEL OF FUNDING BY PROGRAM - CONTINUED

(Dollars in Thousands)

| PROGRAM ELEMENT | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| U.S. ANTARCTIC PROGRAM | | | | | |
| U.S. ANTARCTIC RESEARCH PROGRAM | | | | | |
| U.S. Antarctic Research Program | $13,522 | $15,500 | $15,500 | $17,500 | $2,000 |
| Total | 13,522 | 15,500 | 15,500 | 17,500 | 2,000 |
| ANTARCTIC OPERATIONS PROGRAM | | | | | |
| Science Support | 19,100 | 26,000 | 19,300 | 26,000 | 6,700 |
| Program Operations and Maintenance | 66,143 | 66,200 | 68,053 | 76,200 | 8,147 |
| Total | 85,243 | 92,200 | 87,353 | 102,200 | 14,847 |
| MAJOR CONSTRUCTION AND PROCUREMENT | | | | | |
| Major Construction and Procurement | 25,900 | 33,300 | 28,300 | 36,300 | 8,000 |
| Total | 25,900 | 33,300 | 28,300 | 36,300 | 8,000 |
| TOTAL, USAP | 124,665 | 141,000 | 131,153 | 156,000 | 24,847 |
| Unobigated Balance and Other Adjustments | 134 | 0 | (153) | 0 | 153 |
| U.S. Antarctic Program Appropriation | 124,799 | 141,000 | 131,000 | 156,000 | 25,000 |
| TOTAL, NSF APPROPRIATION | $1,717,000 | $1,930,000 | $1,885,000 | $2,149,022 | $264,022 |

## *ANALYSIS OF CHANGES IN OBLIGATION LEVELS:FY 1988-FY 1990*

## RESEARCH AND RELATED ACTIVITIES APPROPRIATION

### (DOLLARS IN THOUSANDS)

| | Obligations |
|---|---|
| FY 1988 Obligated Level | $1,458,272 |
| FY 1989: | |
| Increases: | |
| Biological, Behavioral and Social Sciences | 16,450 |
| Computer and Information Science and Engineering | 28,167 |
| Engineering | 15,186 |
| Geosciences | 19,627 |
| Mathematical and Physical Sciences | 31,222 |
| Program Development and Management | 7,184 |
| Science and Technology Centers | 326 |
| Scientific, Technological and International Affairs | 8,282 |
| Subtotal | 126,444 |
| FY 1989 Obligated Level | 1,584,716 |
| FY 1990: | |
| Increases: | |
| Biological, Behavioral and Social Sciences | 32,970 |
| Computer and Information Science and Engineering | 39,120 |
| Engineering | 23,939 |
| Geosciences | 31,018 |
| Mathematical and Physical Sciences | 50,247 |
| Program Development and Management | 12,350 |
| Science and Technology Centers | 19,674 |
| Scientific, Technological and International Affairs | 8,988 |
| Subtotal | 218,306 |
| FY 1990 Obligated Level | 1,803,022 |

## *ANALYSIS OF CHANGES IN OBLIGATION LEVELS:FY 1988-FY 1990*

## SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION

**(DOLLARS IN THOUSANDS)**

| | Obligations |
|---|---|
| FY 1988 Obligated Level | $139,629 |
| FY 1989: | |
| Increases: | |
| Teacher Preparation and Enhancement | 17,994 |
| Materials Development, Research and Informal Science Education | 6,191 |
| Undergraduate Science, Engineering and Mathematics Education | 8,975 |
| Studies and Program Assessment | 1,260 |
| Subtotal | 34,420 |
| Decrease: | |
| Research Career Development | (3,005) |
| FY 1989 Obligated Level | 171,044 |
| FY 1990: | |
| Increases: | |
| Teacher Preparation and Enhancement | 4,975 |
| Materials Development, Research and Informal Science Education | 4,998 |
| Undergraduate Science, Engineering and Mathematics Education | 1,999 |
| Research Career Development | 6,984 |
| Studies and Program Assessment | 0 |
| Subtotal | 18,956 |
| FY 1990 Obligated Level | 190,000 |

## *ANALYSIS OF CHANGES IN OBLIGATION LEVELS:FY 1988-FY 1990*

## U.S. ANTARCTIC ACTIVITIES APPROPRIATION

### (DOLLARS IN THOUSANDS)

| | Obligations |
|---|---|
| FY 1988 Obligated Level | $124,665 |
| FY 1989: | |
| Increases: | |
| U.S. Antarctic Research Program | 1,978 |
| Antarctic Operations | 2,110 |
| Major Construction and Procurement | 2,400 |
| Subtotal | 6,488 |
| FY 1989 Obligated Level | 131,153 |
| FY 1990: | |
| Increases: | |
| U.S. Antarctic Research Program | 2,000 |
| Antarctic Operations | 14,847 |
| Major Construction and Procurement | 8,000 |
| Subtotal | 24,847 |
| FY 1990 Obligated Level | 156,000 |

## PERCENTAGE DISTRIBUTION OF TOTAL OBLIGATIONS: FY 1988 - FY 1990

| | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN FY 1989 | ESTIMATE FY 1990 |
|---|---|---|---|---|
| Research and Related Activities | | | | |
| Biological, Behavioral and Social Sciences | 15.4% | 14.8% | 14.9% | 14.6% |
| Computer and Information Science and Engineering | 7.2% | 7.7% | 8.1% | 8.9% |
| Engineering | 10.0% | 10.1% | 9.9% | 9.8% |
| Geosciences | 16.9% | 16.5% | 16.5% | 15.9% |
| Mathematical and Physical Sciences | 27.4% | 25.8% | 26.7% | 25.8% |
| Program Development and Management | 4.9% | 5.0% | 4.9% | 4.8% |
| Science and Technology Centers | 0.0% | 1.6% | -- | 0.9% |
| Scientific, Technological and International Affairs | 2.9% | 3.1% | 3.1% | 3.1% |
| Subtotal, Research and Related Activities | 84.7% | 84.6% | 84.1% | 83.8% |
| Science and Engineering Education | | | | |
| Teacher Preparation and Enhancement | 2.6% | 2.8% | 3.4% | 3.2% |
| Materials Development, Research and Informal Science Education | 2.2% | 2.3% | 2.3% | 2.3% |
| Undergraduate Science, Engineering and Mathematics Education | 1.1% | 1.2% | 1.5% | 1.4% |
| Research Career Development | 2.0% | 1.6% | 1.6% | 1.8% |
| Studies and Program Assessment | 0.2% | 0.2% | 0.2% | 0.2% |
| Subtotal, Science and Engineering Education | 8.1% | 8.1% | 9.0% | 8.9% |
| U.S. Antarctic Program | | | | |
| U.S. Antarctic Research Program | 0.8% | 0.8% | 0.8% | 0.8% |
| Antarctic Operations | 4.9% | 4.8% | 4.6% | 4.8% |
| Major Construction and Procurement | 1.5% | 1.7% | 1.5% | 1.7% |
| Subtotal, U.S. Antarctic Program | 7.2% | 7.3% | 6.9% | 7.3% |
| Total, NSF | 100.0% | 100.0% | 100.0% | 100.0% |

## SUMMARY OF OBLIGATIONS BY MAJOR OBJECT CLASSIFICATION (Dollars in Thousands)

| | ACTUAL FY 1988 | REQUEST FY 1989 | CURRENT PLAN* FY 1989 | ESTIMATE FY 1990 | DIFFERENCE |
|---|---|---|---|---|---|
| Research and Related Activities | | | | | |
| Personnel Compensation | $51,607 | $54,750 | $54,160 | $57,973 | $3,813 |
| Personnel Benefits | 7,304 | 7,555 | 7,978 | 8,566 | 588 |
| Travel and Transportation of Persons | 2,738 | 3,500 | 3,500 | 3,750 | 250 |
| Transportation of Things | 186 | 270 | 230 | 230 | 0 |
| Rents and Communications | 10,489 | 12,130 | 11,120 | 11,895 | 775 |
| Printing and Reproduction | 736 | 650 | 750 | 820 | 70 |
| Other Contractual Services | | | | | |
| Program Contracts | 83,490 | 173,350 | 155,480 | 159,352 | 3,872 |
| Prog.Devel.& Mgt.Contract Services | 7,199 | 10,600 | 8,570 | 12,281 | 3,711 |
| Supplies and Materials | 755 | 1,065 | 800 | 905 | 105 |
| Equipment | 3,436 | 5,000 | 4,512 | 7,550 | 3,038 |
| Grants, Subsidies, Contributions | | | | | |
| Program Contracts | 1,290,216 | 1,364,100 | 1,336,486 | 1,539,670 | 203,184 |
| Program Development and Management Grants | 16 | 30 | 30 | 30 | 0 |
| Subtotal, Research and Related Activities | 1,458,272 | 1,633,000 | 1,583,616 | 1,803,022 | 219,406 |
| Science and Engineering Education | | | | | |
| Program Contracts | 4,265 | 2,000 | 4,044 | 4,000 | (44) |
| Program Grants | 135,364 | 154,000 | 167,000 | 186,000 | 19,000 |
| Subtotal, Science and Engineering Education | 139,629 | 156,000 | 171,044 | 190,000 | 18,956 |
| United States Antarctic Program | | | | | |
| Program Contracts | 111,841 | 125,000 | 115,000 | 138,000 | 23,000 |
| Program Grants | 12,824 | 16,000 | 16,153 | 18,000 | 1,847 |
| Subtotal, United States Antarctic Program | 124,665 | 141,000 | 131,153 | 156,000 | 24,847 |
| TOTAL NSF | $1,722,566 | $1,930,000 | $1,885,813 | $2,149,022 | $263,209 |

* This table reflects the transfer within the Research and Related Activities Appropriation of $1,100,000 from program grants to personnel compensation and benefits. The transfer will be made upon approval of the requested increase in the FY 1989 PD&M limitation to cover increases resulting from the FY 1989 government-wide pay adjustment.

## NSF APPROPRIATION LANGUAGE

### RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; acquisition of [one] aircraft; hire of passenger motor vehicles; not to exceed [$2,500] *$6,000* for official reception and representation expenses; uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901-5902); rental of conference rooms in the District of Columbia; and reimbursement of the General Services Administration for security guard services; [$1,583,000,000] *$1,803,022,000*, to remain available until September 30, [1990] *1991*: *Provided,* [That of the funds appropriated in this Act, $900,000 shall be available only for the International Institute for Applied Systems Analysis, and that, notwithstanding any other provision of law, the Director may choose not to obligate these funds for that purpose: *Provided further,* That of the funds appropriated in this Act, or from funds appropriated previously to the Foundation, not more than $90,550,000 shall be available for program development and management in fiscal year 1989: *Provided further,* That none of the funds appropriated in this Act may be used, directly or through grants, contracts, or other awards mechanisms, for agreements executed after enactment of this Act, to pay or to provide reimbursement for the Federal portion of the salary of any individual functioning as a Federal employee at more than the daily equivalent of the maximum rate paid for ES-6 for assignments to Senior Executive Service positions, unless specifically authorized by law: *Provided further,* That notwithstanding the preceding proviso, none of the funds appropriated in this Act may be used to pay the salary of any individual functioning as a Federal employee, or any other individual, through a grant or grants at a rate in excess of $95,000 per year: *Provided further,]* That contracts may be entered into under the program development and management [limitation] *activity* in fiscal year [1989] 1990 for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further,* That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation: [*Provided further,* That of the funds appropriated in this Act, not more than $73,480,000 shall be available for advanced scientific computing, networking and communications research and infrastructure: *Provided further,* That none of the funds appropriated in this Act may be made available for a new academic research facilities program:] *Provided further,* That to the extent that the amount appropriated is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally. *(Department of Housing and Urban Development-Independent Agencies Appropriations Act, 1989.)*

## NSF APPROPRIATION LANGUAGE, continued

### SCIENCE *AND ENGINEERING* EDUCATION ACTIVITIES

For necessary expenses in carrying out science and engineering education programs and activities pursuant to the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including services as authorized by 5 U.S.C. 3109 and rental of conference rooms in the District of Columbia, [$171,000,000] *$190,000,000*, to remain available until September 30, [1990] *1991*: *Provided*, That to the extent that the amount of this appropriation is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally. *(Department of Housing and Urban Development-Independent Agencies Appropriations Act, 1989.)*

## NSF APPROPRIATION LANGUAGE, continued

### UNITED STATES ANTARCTIC PROGRAM ACTIVITIES

For necessary expenses in carrying out the research and operational support for the United States Antarctic Program pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); maintenance, and operation of aircraft and purchase of flight services for research and operations support; maintenance and operation of research ships and charter or lease of ships for research and operations support; improvement of environmental practices and enhancement of safety; hire of passenger motor vehicles; not to exceed [$1,000] *$2,500* for official reception and representation expenses; [$131,000,000] *$156,000,000,* to remain available until expended: *Provided*, That receipts for support services and materials provided for non-Federal activities may be credited to this appropriation *[Provided further*, That no funds in this account shall be used for the purchase of aircraft other than ones transferred from other Federal agencies: *Provided further*, That no funds in this Act shall be used to acquire or lease a research vessel with ice-breaking capability built by a shipyard located in a foreign country if such a vessel of United States origin can be obtained at a cost no more than 50 per centum above that of the least expensive technically acceptable foreign vessel bid: *Provided further*, That, in determining the cost of such a vessel, such cost be increased by the amount of any subsidies or financing provided by a foreign government (or instrumentality thereof) to such vessel's construction: *Provided further, That a new competitive solicitation for such vessels shall be conducted: Provided further,* That if the vessel contracted for pursuant to the foregoing is not available for the 1989-1990 austral summer Antarctic season, a vessel of any origin may be leased for a period of not to exceed 120 days for that season and each season thereafter until delivery of the new vessel: *Provided further*, That the preceding four provisos shall not apply to appropriated funds used for the lease of the vessel POLAR DUKE]. *(Department of Housing and Urban Development-Independent Agencies Appropriations Act, 1989.)*

## APPENDIX 2

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
*Washington, DC, January 27, 1989.*

Hon. ROBERT A. ROE,
*Chairman, Committee on Science, Space, and Technology,*
*House of Representatives, Washington, DC.*

DEAR MR. CHAIRMAN: Section 14(j) of the National Science Foundation Act of 1950 (42 U.S.C. 1873) (j) requires the Foundation to submit to Congress a three-year budget estimate which includes estimates for each major activity, the United States Antarctic Program, and the Science and Engineering Education Directorate. These estimates are contained in the attachment to this letter.

The estimates for Fiscal Years 1991 and 1992 indicate continued support for the programs and initiatives explained in the Foundation's budget request for FY 1990.

Sincerely,

ERICH BLOOH,
*Director.*

Attachment.

National Science Foundation.—FUNDING ESTIMATES FOR MAJOR ACTIVITIES

[In thousands of dollars]

| Activity | Fiscal Year— | | |
|---|---|---|---|
| | 1990 estimate | 1991 estimate | 1991 estimate |
| Biological, Behavioral, and Social Science | 314,500 | 351,000 | 399,000 |
| Computer and Information Science and Engineering | 191,200 | 213,100 | 242,000 |
| Engineering | 211,200 | 236,000 | 268,000 |
| Geosciences | 341,300 | 381,000 | 433,000 |
| Mathematical and Physical Science | 553,500 | 618,000 | 702,000 |
| Program Development and Management | 104,000 | 111,900 | 120,000 |
| Science and Technology Centers | 20,000 | [1] 22,000 | [1] 25,000 |
| Scientific, Technological and International Affairs | 67,322 | 75,000 | 85,000 |
| Subtotal Research and Related | 1,803,022 | 2,008,000 | 2,274,000 |
| Science and Engineering Education | 190,000 | 201,000 | 213,000 |
| U.S. Antarctic Program | 156,000 | 179,000 | 190,000 |
| Total NSF | 2,149,022 | 2,388,000 | 2,677,000 |

[1] Represents second and third year funding of new awards to be made in 1990.



○